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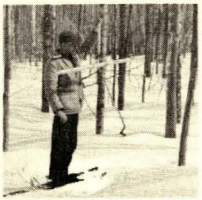

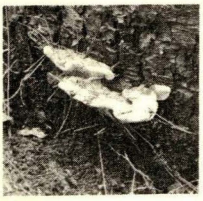

Annual Report

Northeastern Forest Experiment Station
Forest Service, U. S. Dept. of Agriculture

FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE • UPPER DARBY, PA.

1957

Annual Report

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NORTHEASTERN FOREST EXPERIMENT STATION • • 1958
RALPH W. MARQUIS, DIRECTOR

In General...

WE PRESENT this year a more or less matter-of-fact review of programs and accomplishments during 1957, with no special features. The research programs of the different divisions are substantially those of past years, but the careful reader will discern evidences of some changes in emphasis. These changes come slowly. They depend in part on changes in personnel and the possession of new talents by the technical staff. They depend in part on the closing of completed studies and the opportunity to start new ones. They also depend on increased funds for new studies.

Research Programs

In forest management research the major emphasis is still on compartment studies. These are the studies that eventually will tell us the relative biological and financial advantages of different ways of treating the forest stand. But the initial time-consuming jobs of establishing the compartments, marking boundaries, making the initial inventories, and making the first cuts are nearing completion. At one research center these jobs have all been done, so manpower is being released for other studies. With those extra hours, and others made available through increased appropriations, we are turning to studies of a more basic nature: studies of soils and sites, studies of stand structure, studies of regeneration, vegetative propagation, and soil nutrients and light.

The biggest change in the watershed management research program has come with the completed calibration of our watersheds at two experimental forests. Now the stands are being treated--cut on one forest, planted on the other--to show what effect different treatments have on the water economy. Most of our work so far has been with surface water and forest stands. Our thinking is now turning also to municipal watersheds and to ground-water supplies. We are expanding our studies largely through cooperative arrangements with forest schools and other agencies. We are looking forward to an even greater integration of our studies with those of the other divisions, such as studies of

soil moisture in relation to site, vigor, pathological conditions, and the like.

In forest insect research we are turning away from the trial and error method of field tests for insecticides and toward laboratory pretesting. We are also looking more to other means of control; irradiation of males, diseases of insects, and other biological controls. These necessarily call for more knowledge of the insects themselves, their diseases, and their parasites. We are continuing our studies of the various factors that may make trees resistant to insect attack.

Personnel changes in the Division of Forest Disease Research gave us an opportunity to move some of our studies from the laboratory to the field. Our studies of fungi and viruses have not been wasted, but our new approach involves more work in the field with living and dying trees, more emphasis on the control of forest disease and its damage, and closer integration of the studies with forest and watershed management research.

In forest utilization research the form of our effort is also changing. At first we were doing a selling job--trying to interest the forest industries in new technologies, new equipment and processes, new products. The industries know about these things now, and they are coming to us for advice in keeping themselves oriented to new developments. We now also have authority to do project research in utilization, but are still awaiting the finances and facilities needed for these studies.

In Forest Survey our change in thinking comes as the completion of the initial survey approaches and as plans for maintenance of the survey must be made. So we are engaging more actively in research in forest survey techniques, and experimenting with a system of continuous forest inventory. Emphasis in our production and marketing studies is changing, too: instead of looking back to see what practices have been profitable in the past, we are studying trends, new techniques, and promising developments to find out what practices will be profitable in the immediate future.

Station Affairs

Increases in funds appropriated for Fiscal Year 1958 have permitted some expansion in our studies in forest management research, forest disease research, and forest survey techniques. No new units have been established; instead we have strengthened our staffs at Burlington, Vt.; Laconia, N.H.; and Bangor, Maine. In addition we have been able to

bolster our supporting services at the headquarters office in Upper Darby.

During 1957 seven of our technical personnel left the Station. Three retired: Glen Hahn and Alma Waterman from the Forest Disease Laboratory, and Fred Potts from the Forest Insect Laboratory. Two resigned: Russell Hutnik to accept a research position with Pennsylvania State University, and Jonathan Wright to do research and teach genetics at Michigan State. Two transferred: John McGuire, to the California Forest and Range Experiment Station, and Norman Griswold, to Region 7.

Eighteen new technical men joined our staff during the year. Barton Blum, David Dickson, Robert Frank, and Allan Hartong have joined Forest Survey, and Elliot Amidon and Robert Marty are new in Resource Economics. Raymond Leonard has been assigned to watershed management research at Laconia, N.H. There are three new men in forest disease research: Robert Brandt and Kemper Callahan at the New Haven Laboratory and Kenneth Bromfield at Laconia. Wendell Smith occupies a newly established position as editorial assistant in Upper Darby. In forest management there are seven new technical men. Frank Santamour is at the Morris Arboretum, Elwood Shafer at Paul Smiths, Oscar Atkinson at Burlington, Donald Scott and David Marquis at Laconia, Thomas Percy (now on educational leave) at Bangor, and Harry Yawney at Parsons, W. Va.

Three of our men--Kemper Callahan, Donald Lester, and John Phillips--entered military service during the year. And six are doing graduate work: George Yelenosky at Penn State, Ed Sucoff at the University of Maryland, John Staley at Cornell, Thomas Percy at Rutgers, and Adrian Gilbert and Herbert Tepper at Syracuse. Robert Wilson returned to duty with the Station after graduate work at Yale.

Because of the many changes in personnel we have tried to hold internal transfers to a minimum, but a few were necessary to balance our program. G. R. Trimble moved from Laconia to Elkins, W. Va., to fill the center leader vacancy. Thomas McIntyre went to the research center at Beltsville. William Leak moved from Laconia to Burlington, and Sam Brock, graduating from Forest Survey, settled down at Bangor.

We now have 33 technical men who have been with the Station less than 2 years; most of them are equally new to the Forest Service. All have had good technical training; most of them hold an M.S. degree, several a Ph.D. But to become most effective in a research organization many of these men can benefit from additional training in one or

more fields--administrative procedures, safety, fire control, photography, writing and speaking, log grading, statistics and experimental design, and many others. On-the-job training begins the day a new man reports, and continues with diminishing intensity for the first several years. Specialized training in statistics, photography, writing, and log grading is given most effectively through organized courses. The training program will be one of our major responsibities in coming years.

A new division, the Division of Station Management, is being established at Upper Darby. The position of Division Chief has not been filled, but Robert Bain is serving as Assistant Chief. The new division will better enable us to serve an expanding field organization.

--RALPH W. MARQUIS
Director

Forest Management

THE YEAR'S major event for the Division of Forest Management Research was the increased appropriation for research in the management of New England hardwoods. The forest management research staff is now being increased at the White Pine-Hardwood and Penobscot Research Centers, at the Burlington, Vt., project, and at Upper Darby. Also, facilities needed for more basic research can now be financed. For example, a small greenhouse will be erected on the campus at the University of Vermont and a modest laboratory will be established at the headquarters of the White Pine-Hardwood Research Center.

New research studies of New England hardwoods, already begun or planned for the near future, include the following subjects:

- Interrelationships between management practices and tree diseases.
- Value increment of important species grown under selected stand structures and stocking levels.
- Methods for improving juvenile stands.
- Cutting practices and seedbed treatments that will favor natural regeneration of the more desirable species.
- Effect of soil moisture, temperature, and weather upon regeneration and growth.
- Seed-crop intervals and seed viability of several important species.
- Physiology of flowering and fruiting of sugar maple, birch, and other important hardwoods.
- Nutrient requirements of hardwoods for maximum growth, and, for sugar maple, for maximum sugar content of sap.

Results and progress in some of the current or recent research in forest management at the Station's several research centers and at the Morris Arboretum are summarized

below. Much of the work has been done in cooperation with State agencies, other Federal agencies, universities, and private organizations.

F O R E S T T R E E P H Y S I O L O G Y

Our research in forest tree physiology includes studies of nutrient and light requirements, and of methods of vegetative propagation. This work was done at the Virginia Pine-Hardwood and White Pine-Hardwood Research Centers.

Nutrient Requirements Of Loblolly And Virginia Pines

A study of the importance of different amounts of potassium, calcium, and magnesium in the early growth of loblolly and Virginia pines was undertaken early in 1957 in cooperation with the University of Maryland. Seedlings were grown in sand culture in pots, and each pot was watered hourly from its own reservoir to keep the moisture and air of the root medium at adequate levels (fig. 1). Each reservoir contained a nutrient solution complete in all essential elements except the particular element being studied. In all, 96 pots were used, 36 to test the effects of six different levels of potassium, and 60 to test 3 levels of magnesium x 5 levels of calcium. With all other growth factors held constant and adequate, growth differences may be attributed to differences in amount of nutrient.

Height measurements of the seedlings were made in December 1957; and in January 1958 the plants will be harvested and the foliage analyzed for mineral content. If foliar concentrations of nutrients are found to be related to growth and to nutrient solution concentrations, foliar analysis may prove useful in determining soil fertility and fertilization needs in the field.

When either potassium or magnesium was supplied at 0.01 milliequivalents (meq.)/liter, deficiency symptoms appeared in seedlings of both species. When potassium was deficient, height growth was much stunted; terminal needles were purple and spiraled; few secondary needles developed; and on the larger plants the older needles died back. When magnesium was deficient, height growth was much stunted; needle tips became bright yellow, followed by necrosis; and eventually there was dieback, beginning in the branches and progressing to the main stem.

Height measurements indicated that 0.35 meq. of calcium and 2.0 meq. of magnesium per liter were adequate for healthy growth. For potassium, growth was only slightly

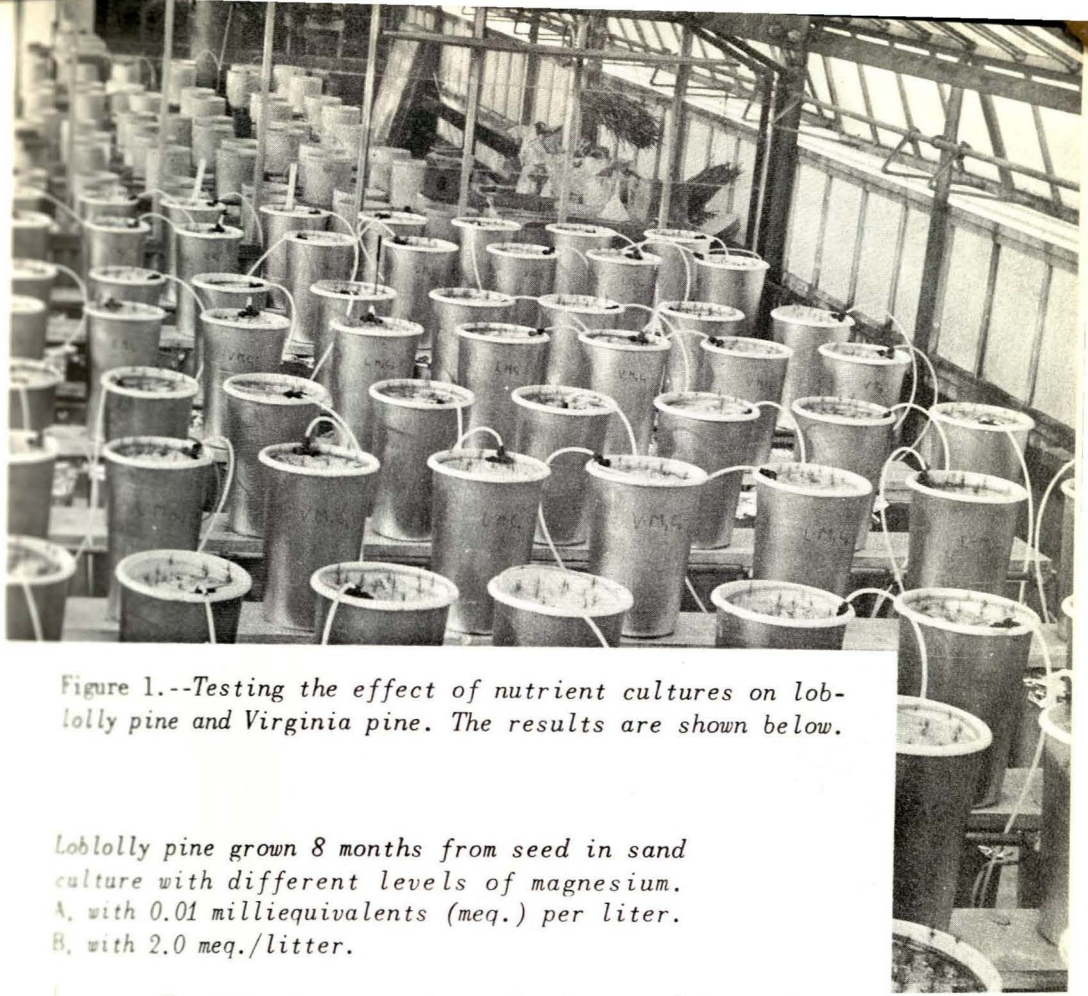


Figure 1.--*Testing the effect of nutrient cultures on loblolly pine and Virginia pine. The results are shown below.*

Loblolly pine grown 8 months from seed in sand culture with different levels of magnesium.
A, *with 0.01 milliequivalents (meq.) per liter.*
B, *with 2.0 meq./litter.*

Virginia pine grown 8 months from seed in sand culture with different levels of potassium.
C, *with 0.01 meq./liter.* D, *with 3.5 meq./liter.*

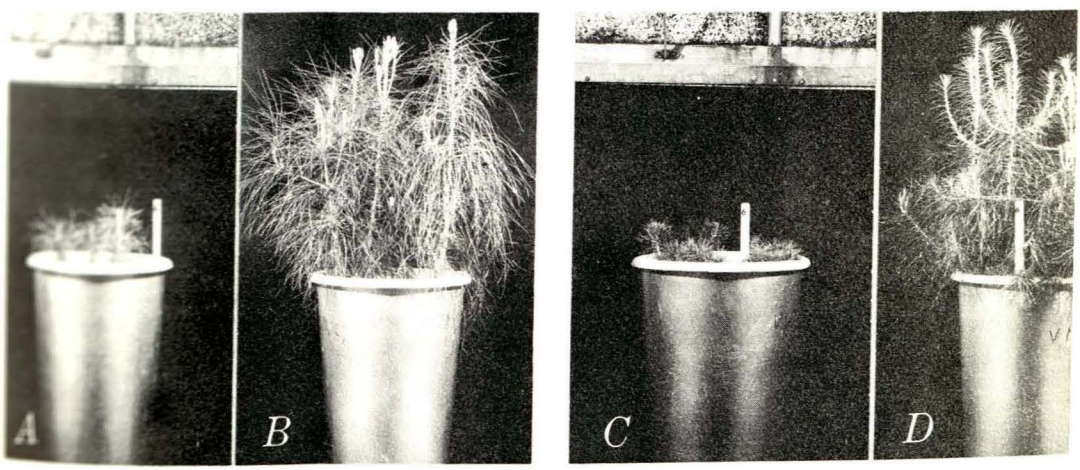
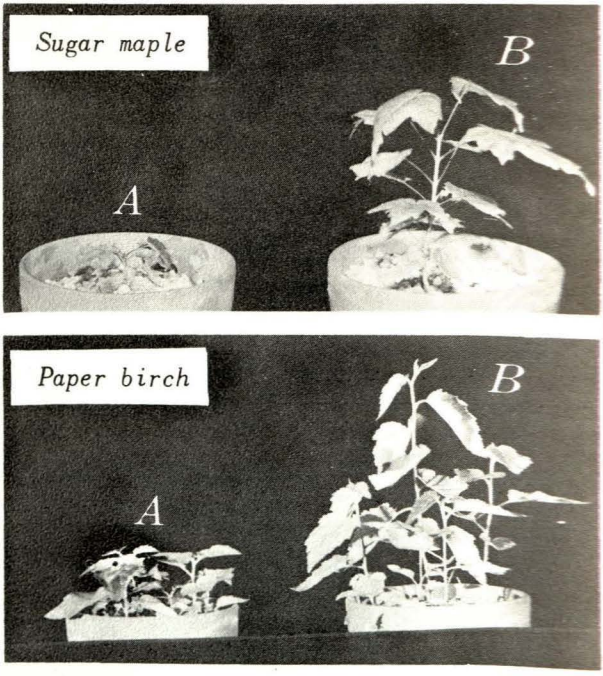


Figure 2.--*Testing growth response of tree seedlings to supplemental light. Incandescent bulbs were used to give seedlings extra light.*



The seedlings marked A *were grown in normal daylight at Beltsville, Md. Seedlings marked* B *were grown under supplemental lighting that increased day length to 18 hours. Incandescent bulbs used gave light intensity of about 45 foot-candles.*

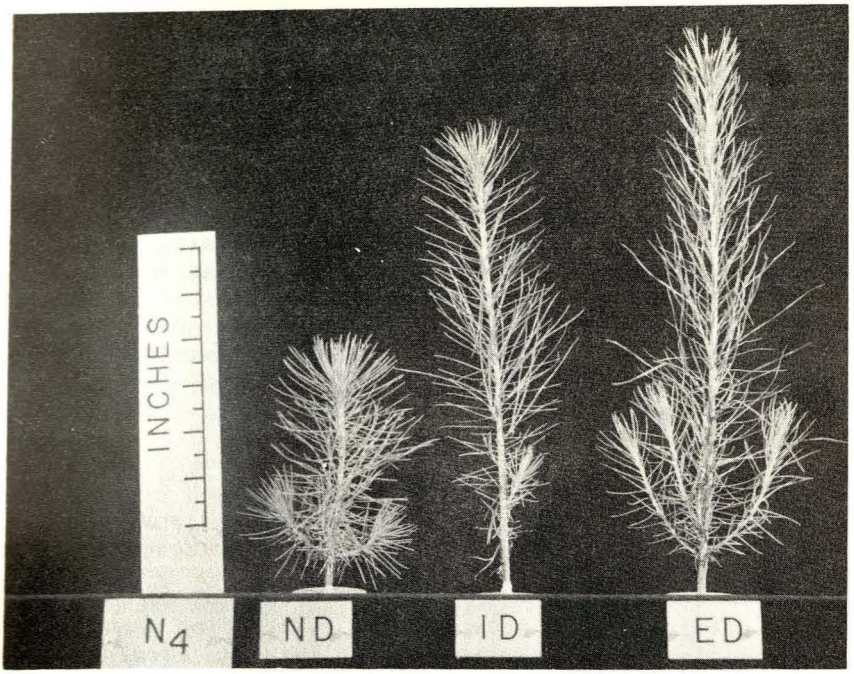


Figure 3.--*Light treatment of loblolly pine not only increased height growth; it also produced more secondary needle fascicles. The greater photosynthetic surface may contribute to the greater height growth and root extension obtained. ND, seedling grown in normal daylight; ID, hours of darkness interrupted with artificial light; ED, daylight hours extended with artificial light.*

retarded at 0.1 meq./liter; the adequacy level may lie somewhere between 0.1 and 1.0.

Influence Of Light On Growth Of Tree Seedlings

During the 1957 growing season, seedlings of 28 tree species were grown out of doors under 7 different light treatments (fig. 2). Natural daylight was supplemented by using incandescent bulbs to give a light intensity varying from 30 to 90 foot-candles. In some treatments the extra light was given in the middle of the night; in others the artificial light was used to extend natural daylight.

Species that responded to extra light with considerable growth increases included white oak, sugar maple, paper and yellow birches, black locust, hybrid poplar, and loblolly, Virginia, and pitch pines. Some species such as red maple, sycamore, and white, jack, and slash pines showed only moderate responses; and some, such as black cherry, mugho pine, and Norway spruce, did not respond at all.

These preliminary studies of the basic responses of tree seedlings to light will furnish information of practical significance in tree nursery operations. Also, a more complete knowledge of these responses will enable foresters to provide better seedling environments in the woods and may lead to improved stocking of the desired species.

Vegetative Propagation

Tests of three rooting media for sugar maple were begun in cooperation with the University of Vermont. Some 8,700 cuttings from selected sugar-producing phenotypes of sugar maple in four states were planted in equal numbers in perlite (an inert volcanic material), sawdust, and a mixture of sphagnum moss, peat, and sand in equal parts.

Rooting differed significantly among the three media: of the 1,054 cuttings rooted in the experiment, 45 percent were in perlite, 35 percent in sawdust, and 20 percent in the moss-peat-sand mixture. Differences in rooting ability of trees also were indicated by this study. The variation in rooting among clones ranged from 0 to 62 percent for perlite, 0 to 35 for the moss-peat-sand, and 0 to 42 for sawdust.

Small-scale studies of rooting sugar maple by air-layering were started at the Hopkins Memorial Experimental Forest in 1954 and continued through 1957. A few rooted specimens have been obtained from this work and are now growing at the Forest nursery. Some of the tests made this year promise to yield additional specimens. The main findings of this research are:

- Treatments applied around the middle of June give best results in this general area.

- Older wood is more responsive to treatment than newer wood. Treatments applied at the node between the 1-year wood and the 2-year wood gave 30 percent rooting. Treatments applied at the node between the greenwood and the 1-year wood gave 22 percent rooting.

- The greater the severity of wounding, provided that it was not severe enough to cause mortality, the better the rooting response. Branches notched on one side only gave 14 percent rooting while those that were completely girdled with a very shallow cut about ¼ inch wide showed 38 percent rooting.

- As a rooting medium, a mixture of soil and sphagnum moss gave somewhat better results (20 percent successful) than sphagnum alone (15 percent), or soil alone (12 percent).

- Shading the treated branches gave no better results than unshaded branches; 15 and 17 percent, respectively.

- Individual trees vary considerably in their rooting response.

In the coming year, methods of wounding designed to increase rooting response, and methods of carrying the rooted material over winter, will be investigated more thoroughly in an attempt to increase survival and growth during the second and subsequent years.

S I L V I C S

Included in the field of silvics are studies dealing with the relationship of browsing animals to forest establishment, zoning for the management of black cherry, and forest sites.

Browsing Animals And Forest Establishment

In some areas of the Northeast, browsing by upland game animals is a definite obstacle to establishing forests by either natural or artificial methods. Studies to determine how seriously browsing animals, especially deer, affect reproduction, and studies in methods of protecting reproduction, are under way on a small scale at several research centers and experimental forests.

Five years ago 1/40-acre deer and rabbit exclosures were built in the Pocono Experimental Forest to evaluate the effect of deer and rabbit browsing upon natural tree reproduction. Results to date show that deer do prevent natural tree reproduction, except for beech and striped maple, and that rabbits have no significant effect at present populations. The contrast between the exclosures and adjacent unprotected areas is striking. Within the exclosures reproduction is dense and tall--more than adequate for establishment of a future timber stand. Some seedlings have

reached an inch in diameter and are 12 to 15 feet tall. Outside the exclosures there is very little woody plant growth except beech and striped maple; seedlings of desirable species are few and none of them are over 4 feet high. The average numbers of seedlings per acre (over 1 foot tall) are compared below:

	Inside exclosures	On unprotected plots
Black cherry	2,507	160
White ash	247	0
Sugar maple	753	0
Red maple	1,227	13
Yellow birch	1,340	67
Sweet birch	420	0
Beech	1,527	2,880
Striped maple	720	1,493
Pin cherry	1,920	13
Aspen	20	0
Gray birch	447	13
Serviceberry	13	0

It has been observed that logging slash seems to protect hardwood seedlings from browsing. Last year a study was made in the Pocono Experimental Forest to determine to what extent browsing had been reduced by slash. The study was made in an area cut to an 11-inch diameter limit in 1952.

The study showed an average of 1,034 black cherry seedlings per acre over 3 feet tall in slash piles but only 84 per acre in the open. Beech, which is practically ignored by deer in the Pocono Mountains, reacted in the opposite way. 52 percent of the sample plots in slash were stocked with beech reproduction over 1-foot tall, but 67 percent of the plots in the open were so stocked. The protection afforded by slash was significant for all desirable timber species combined.

The results of this work suggest that directional felling of harvest trees, lopping and piling slash, or other similar methods may effectively reduce deer browsing of desirable hardwood reproduction.

The effects of deer browsing, the food preferences of deer, and the potential food values of woody plants have been under study at the Coastal Oak-Pine Research Center for several years. The results of this work, conducted in cooperation with state agencies, were combined in a comprehensive report during 1957 and will be published by the Station in the near future.

Zoning For Management Of Black Cherry

A method of zoning forest land for the production of black cherry has been developed by the Allegheny Plateau Research Center. The method should aid forest managers in selecting the most promising areas for concentration of management efforts. Basic factors involved are the frequency and intensity of glaze damage to large saplings and small poles at certain elevational limits, and recognition of forest types favorable and unfavorable for continuous management of black cherry.

Topography and forest cover types were used in delineating zones on base maps of a given tract. This method has been applied, as an illustration, to the 700,000 acres within the boundaries of the Allegheny National Forest (fig. 4). Of the total area, approximately 60 percent lies within the Allegheny hardwood forest type below 2,000 feet in elevation, the zone locally most favorable for intensive management of cherry. The other zones recognized (mixed oak, aspen-pin cherry, hemlock, and Allegheny hardwoods above 2,000 feet) are not favorable for black cherry production.

Deciding upon the elevation that divides serious from less serious glaze damage to young stands may be difficult unless past records of severe glaze storms are available. However, as a general rule, stands in the southern Appalachian Mountains suffer most glaze damage at elevations from 2,000 to 3,000 feet and higher. In the Plateau region of northern Pennsylvania and western New York the critical elevation is lower, usually 1,800 to 2,000 feet. It drops to about 1,000 feet in the Plateau areas of central New York. A detailed description of the zoning method, along with suggested methods of managing black cherry, is being prepared for publication in 1958.

Forest Sites

Last year work was started on two studies of the relationship between tree and stand growth and various site characteristics.

Site studies in northern hardwoods are being carried out in cooperation with the University of Vermont, and the first season's field work was done in even-aged stands on the Green Mountain National Forest. Sampling was confined to one township, in an area of acid till soils, and was designed to cover the range of site conditions supporting northern hardwoods within this general area. Analysis of the data taken is not complete, but preliminary inspection

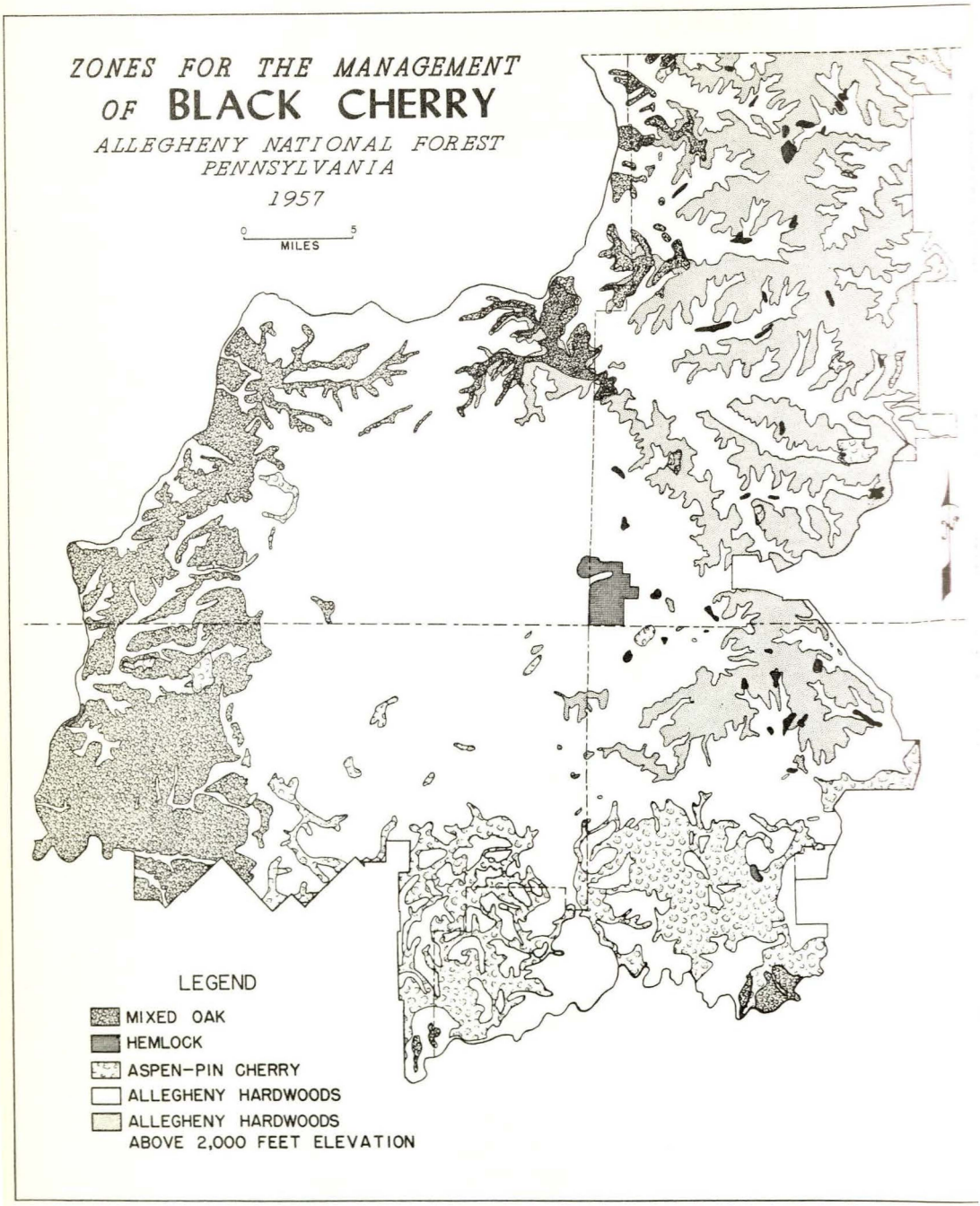


Figure 4.--*An example of zoning forest land for forest management purposes.*

suggests that soil-moisture relationships are important factors in site quality and are also related to observed species composition.

The second study deals with the growth of pure, even-aged stands of white pine in New England. In the first phase of this work, stem analyses of 60- to 70-year-old dominant and codominant trees are being used to determine the height-age relationships for individual trees. In turn, these are being studied for relationships with characteristics of the site and stand. As yet firm conclusions cannot be made, but inspection of the data from 56 sample trees on 22 plots gives rise to these tentative observations.

- The nature of the soil substrata and probably their depth appear to affect the form of the height-age relationship curve when breast height is used as zero age. On six plots the form of the curve was concave upward and five of these plots had a pan. Only one plot with a pan failed to give a clear indication of this curve form.

Deep soils, whether till or outwash, seem to be related to a curve form that is concave downward with current height growth decreasing at a uniform rate.

Shallow to bedrock till soils have about the same curve form except that the curve is flatter beyond roughly 20 years from breast height, indicating a more nearly uniform growth rate beyond that point.

Two deep outwash soils supported trees that exhibited the characteristic sigmoid curve form.

- The height that dominant and codominant trees attain at a given age appears to be affected by soil-moisture relations, but the combination of soil and topographic factors that best express the moisture conditions has not yet been identified.

- Among the subsidiary information accumulated is the fact that the difference in age between stump and breast height for the trees measured ranged from 1 to 10 years with an average of 4 years.

- With respect to leader injuries (caused by the white-pine weevil or any other agency), evidence was accumulated that injury is unrelated to the age or height of the tree at time of attack.

YIELD AND QUALITY

Partial Cuttings In Spruce-Fir Forests

Five-year changes following partial cuttings in four cover types of spruce-fir forests in northern New Hampshire show that the red spruce type made the best growth. Growth responses were intermediate in the balsam-fir and spruce-fir swamp types and lowest in the red spruce-yellow birch type. The spruce component of these stands made the best net growth primarily because mortality and cull were much less than for the other species. Growth comparisons for the first 5-year period after cutting in these stands show:

- The red spruce cover type produced the greatest net growth of the four types studied.
- Of all species covered in the study, spruce made the best net growth.
- Balsam fir had the highest mortality among the species found on the study area.
- Most of fir and spruce mortality observed was caused by wind.
- Residual hardwoods and northern white-cedar were very defective.
- If cull and mortality could be eliminated, growth could be increased by possibly 26 to 87 percent, depending upon the cover type.

Growing-Stock Density

A study of optimum stocking, started a few years ago on the Fernow Experimental Forest, is now beginning to yield results. The first series of plots had a site index (based on the oaks) of about 85; it carried average residual densities of about 80, 60, and 40 square feet of basal area. Later, a second series was established at a site index of about 65; it carried average residual densities of about 50, 40, and 30 square feet of basal area. This study will be rounded out by establishing additional plots at site indexes in the 70's and 50's.

Average annual board-foot and basal-area growth during the first 2 years after the initial cutting showed no striking differences among residual basal-area levels for either

of the two sites. Data are not available for average annual growth for longer periods after the first cutting on the poorer site. On the better site, however, growth records are available for the first 4 years after the initial cutting. These results indicate that growth is greater and is increasing at the two heavier stocking levels but is less and is not increasing at the lowest stocking level. More precise and dependable results, of course, will not be available until the stands have been carried through a few cutting cycles.

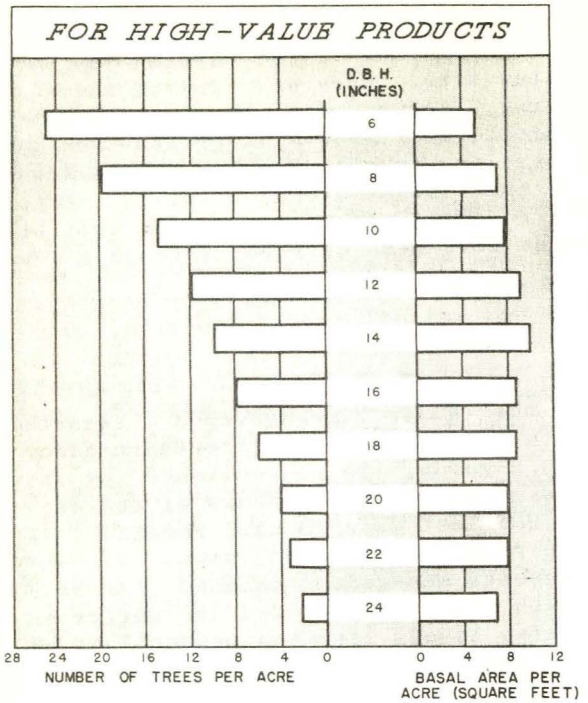
Stand Structure And Stocking

During the year the White Pine-Hardwood Research Center prepared a guide to the management of northern hardwoods in New England. This guide, to be published by the Station during 1958, is based upon several years of research and observations at the Bartlett Experimental Forest. It describes some of the pertinent characteristics of the northern hardwoods and suggests management methods for both old-growth and second-growth forests. Included are suggested stand structures and stocking levels for the production of both high-value and bulk products.

In managing for high-valued products, a stocking of 80 square feet of basal area per acre is suggested (fig. 5). This basal area, distributed among trees 5.0 to 25.0 inches in diameter, corresponds to about 1,900 cubic feet per acre. For a bulk-products objective, the guide suggests a stocking of 60 square feet of basal area per acre in trees ranging from 5.0 to 19.0 inches d.b.h. (fig. 5). With this stocking and structure, much of the growth is in pole timber and most of the products would be of relatively small size.

L O G G I N G C O S T S A N D M E T H O D S

Costs-and-returns relationships have commonly been blamed as major obstacles to wider acceptance of management practices for hardwood forests. Many of the northeastern hardwood stands are located in relatively inaccessible mountainous areas where development and logging costs are high; these and other factors have often led to liquidation cutting. Even so, there are alternatives to liquidation. Proper job organization, efficient skidroad systems, piecework rates or other forms of incentive payments, mechanization, tree-length skidding, and good supervision all contribute to low-cost logging (fig. 6). Tests in mountain hardwoods have demonstrated that even the first cuttings in applying management systems need not be more costly than liquidation or near-liquidation cuts.



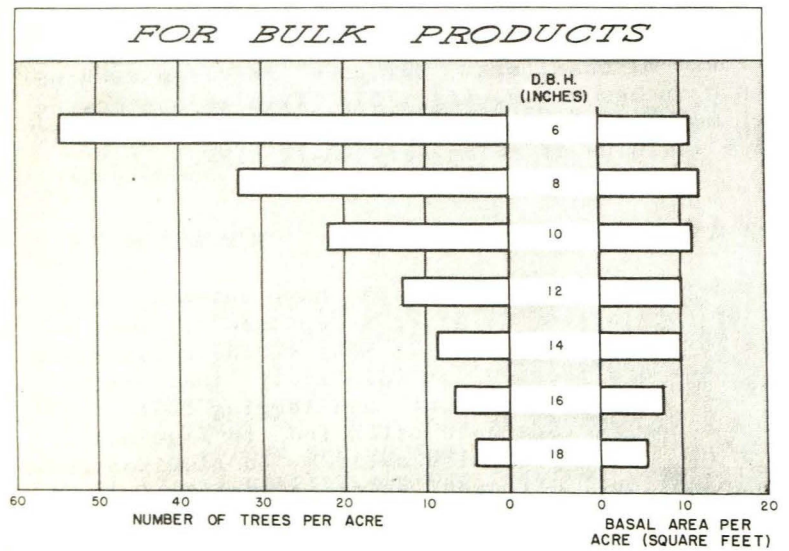


Figure 5.--*Suggested stand and stocking for uneven-aged northern hardwoods after each cutting.*

Figure 6.--*Efficient logging methods that reduce costs provide an alternative to liquidation cutting. Sulky skidding makes bigger loads possible, insures cleaner logs, and reduces wear on skid roads.*

Figure 7.--*The red maple above was treated 31 months earlier with sodium arsenite solution painted on a girdle 8 inches wide. The bark sloughed off the lower two-thirds of the bole but stayed on the rest.*

Experimental cutting under various systems of management for old-growth hardwoods has been under way since 1950 at the Bartlett Experimental Forest. Costs for felling, bucking, and skidding on eight rugged compartments totalling 305 acres and managed under three management systems ranged between $11 and $12 per cord. Cutting under the liquidation system cost the most per cord harvested, the selection system was intermediate in cost, and the diameter-limit system was the least expensive.

The initial cutting on three compartments, each managed under a different system, was completed at the Fernow Experimental Forest during 1957. As at the Bartlett, logging costs varied only slightly among the systems even though they represent quite different brands of forestry. Costs per thousand board feet, gross scale, of logs for each of the management systems were:

Management system	Felling, limbing, and bucking	Skidding	Total
Intensive selection	$6.68	$7.60	$14.28
Extensive selection	6.85	8.59	15.44
Diameter-limit	6.09	8.79	14.88

Production methods and costs, equipment, terrain, timber conditions, and management systems at the two locations were dissimilar; yet these factors were fairly constant within each experimental forest. All of these and other factors as well as costs will, of course, vary with

These red maples were treated with sodium arsenite solution in holes spaced 4 inches apart around the tree. Each hole held about 5 cc of solution. The tree on right has case-hardened and has very little sap-rot. The other two trees have more sap-rot because the bark clung longer, but they still are fit for pulpwood.

time and location. However, the results clearly indicate that even in the initial cuts logging costs need not deter the application of reasonable management systems in mountain hardwoods.

A Simpler Technique For Chemical Debarking

Can the work associated with chemically debarking trees be reduced? Some years ago the Adirondack Research Center reported that trees could be debarked with sodium arsenite applied in frills (Journal of Forestry, May 1956). Results of later exploratory studies now suggest that an even simpler treatment might result in satisfactory debarking--provided the debarking interval can be extended long enough for the treatment and nature to take their courses. Additional research is required to explore this possibility but some preliminary information is available.

Sodium arsenite injected in holes and ax cuts spaced several inches apart has caused the bark to loosen on red maple (fig. 7) and other northern hardwoods in 2 to 3 years. This is 1 to 2 years longer than is required with the painted-girdle method now in general use.

Figure 8.--*Brush-hogging in South Jersey. This machine, much like a rotary lawn mower, easily chops back scrub oak stems, leaving the area as shown in foreground.*

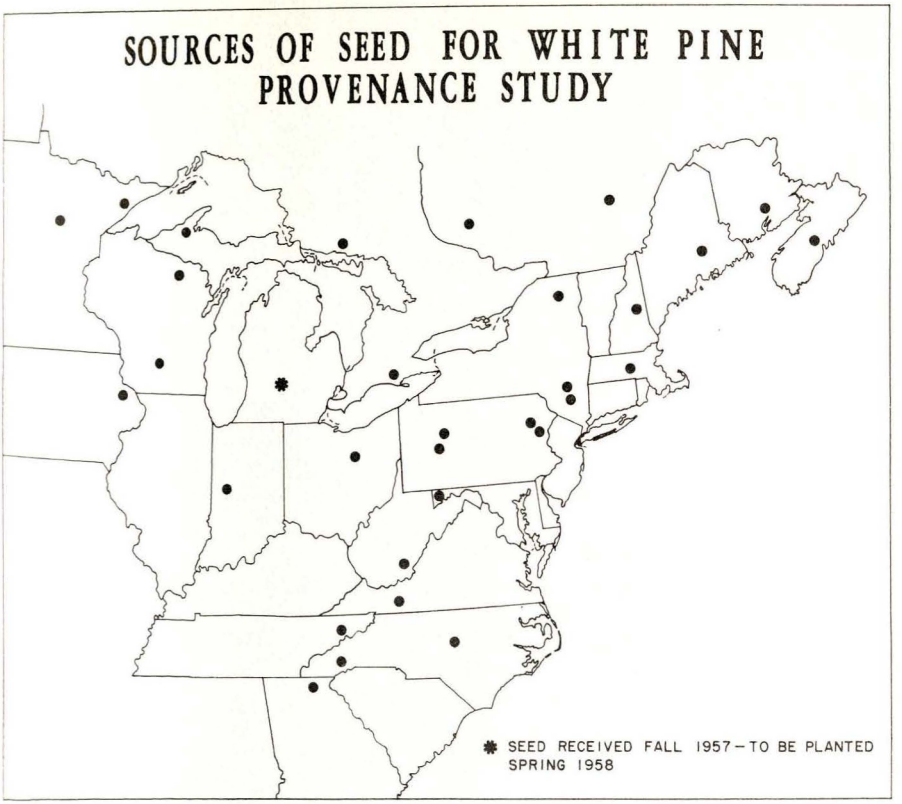


Figure 9.--*The genetic characteristics of white pine are being studied in range-wide provenance tests.*

In 2½ years, only a small amount of sap rot occurred on red maple and beech treated with arsenite placed in holes. Sap rot probably would be more serious on yellow birch or other species from which the bark does not readily slough off.

Assuming that spaced applications of sodium arsenite will satisfactorily loosen the bark of most species in 2 to 3 years, adoption of this simpler treatment probably would depend upon: (1) whether the trees could remain standing that long without serious deterioration of the wood; (2) whether woodland owners could or would anticipate their requirements that far in advance; and (3) whether present treatment costs would be substantially reduced.

Figure 10.--*Primacord blasting fuse was tested for blasting fire line, but results were not encouraging. Here it started seven fires in 30 feet of line.*

FOREST STAND IMPROVEMENT

Research leading to better methods of forest stand improvement is under way at several of the research centers and experimental forests. Two examples of progress are cited here.

Pruning
Red Spruce

A study on the Penobscot Experimental Forest indicates that it may be practical to prune red spruce as well as white pine. Red spruce heretofore has generally been considered a poor investment for pruning because of its slow growth.

In 1951, 127 red spruce and 46 white pine crop trees were pruned to 18 feet. The spruces then averaged 6.1 inches d.b.h. and the pines 7.7 inches. During the next 5 years the spruces put on an average diameter increment of 0.6 inch and the pines 1.0 inch, thus pointing up the well-known fact that white pine is the faster grower and, in general, a better pruning investment. Considerations of costs and rotation ages indicate that a tree must grow more than 0.5 inches in diameter in 5 years to pay for pruning. Most of the white pines in the study exceeded this growth rate. Among the spruces, however, only about 60 percent of the trees exceeded it. The key to profitable returns with spruce lies, at least in part, in selecting the right trees to prune.

Earlier work at the Penobscot Forest and observations in this study have shown that growth rates of red spruce increase with increasing crown ratios and vigor, but are not much influenced by crown class. The indications are that red spruces in high vigor, with adequate growing space, and having crown ratios of 5 or higher, will grow fast enough to justify an investment in pruning.

Spaced-Cut Technique
For Killing Trees Widely Adopted

The spaced-cut technique for killing trees is less costly than methods involving a complete frill, and almost equally effective. Ax cuts, spaced with 3 to 4 inches of unsevered bark between, are made around the tree at convenient working height. Commercial sodium arsenite solution is injected into the cuts.

This simple, efficient, and economical technique has been applied for stand improvement on about 20,000 acres of woodlands by foresters in and around the Adirondack region. Their reports show that 10,566 acres of native forest and

9,434 acres of conifer plantations have been treated since 1952 when the technique was first shown to visitors at the Paul Smiths Experimental Forest. This extensive use developed before formal publication of the study results. (Results will be published soon in the Journal of Forestry.) Interested people observed the work on the Experimental Forest, then tried the technique on their own lands and induced others to do likewise.

Costs on one 1,800-acre job in natural stands were $6 per acre; on another, of 500 acres, costs excluding travel of crew were $4.30 per acre. One plantation thinning job was done for $10 per acre, as compared to an estimated cost of $40 for ax thinning; other plantations have been thinned for a little over 1 cent per treated tree.

SEEDING AND PLANTING

Research in methods of seeding and planting forest species under a variety of conditions has long been a part of the Division's program and is being continued.

Planting The 1947 Burn In Southern Maine

For several years research at the Massabesic Experimental Forest has included the development of seeding, planting, and hardwood-control methods for rehabilitating the 130,000 acres of southern Maine that were burned over in the 1947 fire.

Direct seeding by airplane and in seed spots generally has been unsuccessful. Seeds dropped on exposed dry surfaces have failed to germinate, destruction by predators has been heavy, and the costs of site preparation and seed protection have been high. Further tests of direct seeding of red and white pines are being planned for next year in a continuing effort to find a successful and inexpensive method.

Plantations of red and white pines have been reasonably successful except where the Pales weevil and excessive exposure were limiting factors. There have been no important differences between these two species in survival, but red pine has generally grown more rapidly than white pine. Planting machines have been used successfully on the Forest and generally are more economical than hand planting.

Before pine plantations can be considered satisfactorily established, competing hardwood growth must be controlled. 2,4,5-T, applied with aircraft, mistblowers, or as

a basal spray, has given excellent kills of birches and white oak. Red oak and red maple are difficult to kill with foliar applications but all species can be controlled with basal sprays.

Results of the Massabesic studies are now providing guides for extensive plantings in the 1947 burn that are being financed from private, State, and Federal funds.

Regenerating Northern Hardwoods

Research in nursery production and field planting of northern hardwoods was started at the Burlington, Vt., project last year. Results to date indicate that germination and survival of sugar maple and yellow birch seeded in nursery beds are influenced by type of seedbed covering material and mulch. These materials may, in turn, affect temperature, moisture, and structure of the surface soil. Dessication (sun-scorch) of sugar maple in field plantings--regardless of the fertilization, shading, or cultivation methods tested--indicates that studies of conditions affecting early root growth and root/shoot ratios may prove rewarding.

Direct Seeding Of Pitch Pine

Recent studies conducted by the Coastal Oak-Pine Research Center are providing information on techniques for direct-seeding pitch pine in New Jersey. For example, good results were obtained from a 1955 test in which seed were sown and covered in previously disked plots. When seed spots were protected by hardware-cloth cones in the disked plots, 82 percent of the seed-spots were stocked with living seedlings at the end of the first growing season; 80 percent were stocked at the end of the third season. Where unprotected, the respective values were 40 and 60 percent (the increase resulted from delayed germination). Results were unsatisfactory in undisked plots.

In 1956, test areas were prepared with a farm tractor and a disk or a brush hog (fig. 8). The latter equipment proved superior. First-year results indicate that a pound of seed (70 percent sound) sown on imperfectly drained sites or 2 pounds on dry sites would provide between 2,800 and 3,800 living seedings per acre at the end of the first growing season. But the abnormally dry weather in 1957 modified these results: as many as 81 percent of the seedlings died in the 1956 seedings.

Since satisfactory and practical methods for direct seeding pitch pine may yet be developed, further tests will be made.

6 x 7 Spacing Satisfactory For Loblolly Pine

In 1939, four different spacings were used in planting 1-year-old loblolly pine seedlings on Maryland's eastern sho e. These spacings varied from 4.0 to 11.3 feet between trees. Eighteen years later the basal areas and total cordwood volumes in pines 4 inches d.b.h. and larger varied with density of the original planting, from 10.2 cords per acre in the widest spacing to 17.8 cords in the 4-foot spacing. But when only the pines 6 inches d.b.h. and larger were considered, the 8-foot spacing had the greatest volume.

Most of the differences were due to the effect of spacing on the number of trees and their diameter growth, not on their height growth. The average diameter of planted pines increased from 4.5 inches in the 4-foot spacing to 7.7 inches in the widest. But trees in the widest spacings were too limby to be most desirable; those in the 4-foot spacing were too spindly. Thus, the 6 x 7-foot spacing now used in planting loblolly pine on Maryland's Eastern Shore seems satisfactory, and probably is the best where commercial row thinnings for pulpwood are feasible in stands 15 to 20 years old.

F O R E S T G E N E T I C S

The Station's forest genetics research program includes work with both hardwoods and conifers. Because of the present widespread interest throughout the Northeast in the improvement of white pine, this genetics report is limited to research with the 5-needled pines.

Breeding

Work in species hybridization of white pines was continued in 1957; and 19 successful hybridizations have been obtained since 1953. The seedlings now in test plantations, ranging from 4 to 8 years in age, represent 13 species combinations. Seeds of 6 additional species crosses and of one backcross, P. strobus x (P. griffithii x P. strobus), will be planted in 1958.

In addition to these species crosses, the following selfed and intraspecific seedlings and/or seeds have also been obtained from controlled breeding:

Female parent x male parent	Seedlings (No.)	Seed (No.)
P. ayacahuite x selfed	--	224
P. flexilis x flexilis	--	44
P. griffithii x selfed	4	--
P. griffithii x griffithii	60	1030
P. strobus x selfed	7	--
P. strobus x strobus (Racial hybridization study)	518	3900

White-Pine Weevil Resistance

A preliminary study of 72 natural stands and plantations of P. strobus, and of 10 introduced white pine species in arboretums and forest plantings, was started in 1952 and has now been completed. No evidence of differences in inherent resistance to weeviling was found among local races of eastern white pine. But in 5 of the 72 stands that were studied, there was some evidence of variation in the susceptibility of individual trees. Western white pine (P. monticola), studied in 10 arboretums and forest plantings in New York and Pennsylvania, showed the most promise as a source of weevil-resistant germ plasm for breeding. The three next most promising species were Himalayan white pine (P. griffithii), Macedonian white pine (P. peuce), and Mexican white pine (P. ayacahuite).

Range-Wide Provenance Study Of White Pine

This study of eastern white pine provenances is being conducted in cooperation with the Southeastern, Central States, and Lake States Forest Experiment Station of the U. S. Forest Service, and the Southern Research Station of the Ontario Department of Lands and Forests. Since the Northeastern Station will include one-parent progeny tests in the nursery (and, if warranted, in the field) cooperators furnished seed from each of 10 trees chosen at random. Cooperation on seed collection was excellent; cones were received from 31 provenances in 17 states and 4 Canadian provinces (fig. 9).

In the spring of 1957 the seed was planted in three state forest nurseries: Saratoga, N.Y., Washingtons Crossing, N.J., and Harmons, Md., in cooperation with the state forestry organizations.

At the end of the first growing season (November 1957) there was sufficient growing stock to anticipate that, with normal nursery losses, there will be enough 2- and 3-year seedlings for field tests of 30 provenances throughout the Northeast; and nursery comparisons between the progenies of 10 seed trees from each of 20 provenances, 9 from 2 provenances, 7 from 3 provenances, 6 from 2 provenances, 5 from 1 provenance, and 3 from 1 provenance.

F I R E R E S E A R C H

The fire research project begun in 1956 was continued last year. Progress being made in research and problem analyses is described below.

Primacord Tested For Blasting Firelines

The practicality of blasting a fire line with Primacord--a detonating fuse--was tested at the Beltsville Experimental Forest. The objective of the test was to determine if this material might enable a 2- or 3-man smokechaser crew to hold fires that would be beyond their capabilities to contain by conventional methods.

The results were not encouraging. Neither a single nor a double strand of 50-grain cord made a fire line adequate to stop a fire or to backfire from without additional handwork (fig. 10). Where brush held the cord up off the forest floor for even a few inches the explosion was relatively ineffective, and many fires were started in hardwood litter. These results prompted the suggestion by one of the state fire organizations that Primacord or similar material be used to start counter fires. Such a procedure might eliminate the hazard that accompanies setting counter fires between a backfire and the headfire. A detailed report of these tests was published in the October 1957 issue of the U.S. Forest Service Fire Control Notes.

Rate Of Fire Spread Being Studied

Satisfactory control of forest fires requires knowledge of rates of wildfire spread. Several foresters closely allied with fire control in the Northeast have indicated that such information would be extremely helpful. A study

has been designed to obtain better estimates of rates of spread by fuel types, topography, and weather than are now available. A form for collecting the data needed to prepare the improved rate-of-spread estimates was devised and distributed during the spring to cooperating offices of the 12 Northeastern States. Several of the states collected data on a number of wild fires during the spring season. This study will be continued for at least another year.

Fire Problem Analyses

Analyses were made of the fire situation and problems for research in Pennsylvania and in New Jersey. These analyses are now being reviewed with the objective of publishing them in 1958. A similar analysis was begun for the New England States and New York as a unit; it will be completed next year.

--RICHARD D. LANE, Chief
Division of Forest Management Research

Watershed Management

WATERSHED MANAGEMENT research moved ahead at five of the Station's Research Centers. First and foremost, at the Mountain State Research Center, this year marked the completion of a 6-year calibration period for five of the Fernow's nine watersheds; accordingly, watershed treatment was started. At the Kingston Center, 250 acres of the Dilldown watershed were planted, and a soil-moisture study indicated the amount of water used by competing vegetation; also a cooperative research project was begun at State College, Pa. At the White Pine-Hardwood Center, a third weir was constructed at Hubbard Brook, and a road was built into the watershed; watershed plot-research was begun. At the Coastal Oak-Pine Center, a study of the effect of spraying waste water on vegetation was completed. And at the Virginia Pine-Hardwood Center, a cooperative research project was started on watersheds of the city of Baltimore.

New Watersheds

West Virginia has about ten million acres of abandoned land or poor pasture that should be reforested. To determine the effect of this land on streamflow both before and after planting it to trees, an experiment was begun on two watersheds--both abandoned pasture--on the Monongahela National Forest near the Fernow Experimental Forest.

Gaging stations were installed (fig. 11), and a continuous record of streamflow is being obtained. Precipitation is measured on the abandoned land with a network of four standard rain gages and one recording rain gage. Relationships between precipitation and streamflow on these watersheds can be compared with relationships on the gaged forested watersheds.

At the Hubbard Brook Experimental Forest in the White Mountains, a third weir was built at the foot of a 95-acre watershed (fig. 12). Two precipitation-measuring stations were added. Weir-building in this glaciated region has presented problems not the least of which has been the lack of a decent road to the weir sites. But now a permanent all-weather forest road is under construction; 3½ miles of it

were completed in 1957. This brings at least two more weir sites within easy reach of good transportation.

By next summer a farm property that borders the experimental forest will become official field headquarters for the Hubbard Brook project. This 125-acre tract has excellent building sites and a breath-taking view of the rugged mountains across the valley. Also, a section of the basement in the Forestry Building at Laconia will soon be converted into a soils and biological laboratory.

Logging
Gaged Watersheds

Since May 1951, daily climatic and streamflow records have been obtained on five of the Fernow Experimental Forest watersheds. During the past year, a thorough analysis of these records showed that sufficient data had been obtained to establish streamflow behavior. Accordingly, treatment was started with a commercial clear-cutting of Watershed No. 1 (fig. 13).

With logging only partially completed on Watershed 1, differences in water quality are already apparent. Before logging, the highest measured sediment load was 27 parts per million, except for two occasions of extreme high flow. After logging, a sediment load of 50,000 parts per million was recorded after a moderate storm. During this period sediment load in the control watershed has remained negligible.

Although timber is being cut on only one watershed, skid roads have been bulldozed in the three areas yet to be treated. Thus, the effect of road-building on streamflow can be determined independently of timber cutting. So far, water quality has not been impaired in these watersheds. In cooperation with the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior, the water-quality sampling program on the gaged watersheds has been revised to provide more data on chemical changes that are important in fish management.

Seeding
Logging Roads

To help keep logging-road sediment out of streams, an obvious safeguard is to stabilize the soil by seeding after logging. This year demonstration on two logging roads at the Fernow Experimental Forest proved seeding inexpensive and practical. Chaff, the waste from local harvest operations, was obtained without cost and used on part of the job. The rest of the seeding was done with a mixture of purchased

grass seeds, using about 35 pounds to the acre. Fertilizer (10-10-10) was applied at the rate of 500 pounds to the acre, and lime at 2,000 pounds to the acre. A good catch was obtained even though the sowing was made in the middle of a dry summer. The cost--about $100 per mile--was small compared to the value of the road investment saved.

In August 1955, a study was begun on the Bartlett Experimental Forest to find a cheap and easy method of obtaining a vegetative cover on abandoned skid roads. A series of plots were seeded with different grasses, grains, and legumes; half of the plots were treated with lime and fertilizer, and the other half were not treated.

As early as 2 weeks after seeding, the beneficial effect of treatment was observed: the density and height of vegetation on the treated plots were greater than on the untreated plots. A year after seeding, erosion was controlled. By August 1957, the differences in growth and vigor were striking (fig. 14).

The most promising seeds were red top, timothy, orchard grass, tall fescue, creeping red fescue, and birdsfoot-trefoil. The grains that were tried--oats and rye--were unsuccessful. Seed mixtures insure against failure.

Seeding is a quick and easy way to establish an erosion-controlling vegetative cover on abandoned logging roads. It is relatively inexpensive--seed, lime and fertilizer cost only about $1.50 for 100 linear feet of road. Nevertheless, seeding is not intended as a substitute for the regular after-logging-care measures and is not recommended as standard practice on all logging roads. But in critical spots it will prevent erosion and help to maintain skid roads in good condition.

Planting

A Gaged Watershed

In Pennsylvania, 250 acres of the Dilldown watershed in the Delaware-Lehigh Experimental Forest were planted to conifers, part of a treatment to convert the cover on this 1,500-acre scrub-oak watershed. The area planted had been root-raked the previous fall. The remainder of the planting in the watershed will follow a poisoning treatment.

Waste-Water Disposal

In Woodlands

A short-term study near Seabrook, N. J., showed that marked changes in flora and soil characteristics followed the dispersion of large quantities of waste water from a

Figure 11.--*One of the gaging stations on the Fernow Experimental Forest in West Virginia.*

food-processing plant. In spots where 400 to 600 inches of water had been dispersed annually for nearly 7 years, 27 to 100 percent of the trees 1 inch d.b.h. and larger were dead. Diameter growth of surviving trees had been somewhat favored, but probably most of the remaining trees within the zones of concentrated spray will die within a few years. Nearly all tree reproduction, all native shrubs, and most native herbs had already disappeared. In their place had developed a dense cover of elder and many tall herbs--pokeberry, smartweeds, and lambsquarters being the most common.

Forest floors were 2 inches thicker in treated areas than in unsprayed check areas. Herbaceous debris and a greatly increased population of earthworms were creating mull-type forest floors in treated areas, in place of the mors in check areas. Organic matter in the top 6 inches of soil had increased about 30 percent in the treated areas. Soil acidity had decreased. Soils of the sprayed areas had appreciably more calcium, magnesium, nitrogen, phosphorus, and potassium than in the unsprayed plots.

Figure 12.--*A third weir was built at Hubbard Brook Experimental Forest in New Hampshire. Above, during construction; below, the completed gaging station.*

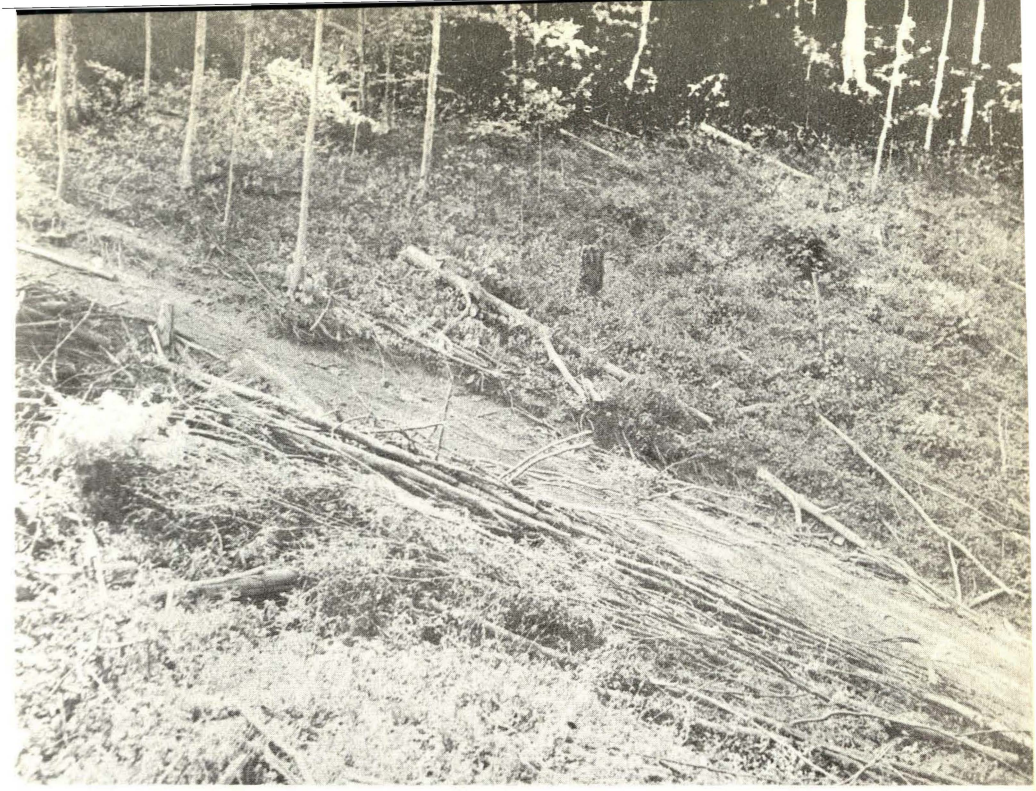


Figure 13.--*Change in water quality due to logging is being studied on this clear-cut watershed. This steep skid road is expected to erode.*

Figure 14.--*Success in revegetating a logging road. Seeding with timothy and red top has produced cover that stabilizes the soil.*

Figure 15.--*Measuring water content of the snowpack. This is part of a snow, frost, and soil-moisture study under way at Hubbard Brook Forest in New Hampshire.*

Waste water will probably eliminate the forest growth in spots that may total 50 acres, but this area provides an economical location for disposing of 5,000,000 to 10,000,000 gallons of waste water daily during the processing season. High infiltration rates will probably continue so long as the soil remains undisturbed and is protected by a mantle of debris.

Plot Studies--
Soil Moisture, Etc.

Soil-moisture samples were taken at the Dilldown and Fernow watersheds to compare soil-moisture drying and wetting under different types of vegetation and treatments. These studies are basic to an understanding of forest-streamflow relationships.

At Dilldown, a study of this kind compared soil moisture regimens of different vegetal covers. On one plot all vegetation was killed, but the humus layer was left intact On another plot only the scrub oak was removed; the ground cover was left intact. On a third plot only the ground cover was killed. A fourth plot was scalped of all vegetation and its humus layer, while a fifth plot served as a control.

Differences in soil moisture during the driest part of the summer (August) were obvious and statistically highly significant. Lowest soil moistures were found on the control plot, with the ground cover plot only slightly higher. The deadened plots were the wettest, with the scalped plot in an intermediate range. Undoubtedly, the humus layer on the deadened plot acted as a mulch that reduced evaporation.

At the Fernow Forest, soil-moisture measurements were made for a second growing season on five of the gaged watersheds. This was part of a continuing study to determine changes in the soil-moisture regimen from cutting.

Measurements in a late-summer dry period indicated that soil-moisture content in the cut-over area of Watershed No. 1 was more than 10 percent higher than it would have been had no cutting been done. Less rainfall will be required to wet this soil and more water will be available for streamflow.

In connection with this study, a nuclear soil-moisture meter is being tested and techniques for using it in stony forest soils are being developed. If successful this instrument will obviate much of the labor and expense involved in taking gravimetric samples.

Before-treatment measurements of humus depth were made on two of the Fernow watersheds; within a year similar measurements will be made on three more. Periodic measurements after treatment will show the effect of the various cutting practices on humus depth.

At the Hubbard Brook Experimental Forest, snow and frost measurements are being made on three ½-acre plots in a typical northern hardwood stand. Snow, soil frost and soil-moisture measurements will be made on the plots for a 2- to 3-year calibration period (fig. 15). Then two of the plots will be cut--one clear-cut, the other partially cut. The third will be left uncut. Post-cutting measurements will show the effects of cuttings on the factors being studied. This project should provide several keys to streamflow behavior.

Cooperative Projects

During the past year the Pennsylvania Department of Forests and Waters, the School of Forestry at Penn State, and this Station set up a cooperative watershed research project. The Department agreed to furnish land, materials, and a road; the School contributed labor for constructing a weir and taking observations; and the Station provided technical assistance and instruments. After a considerable search, three experimental watersheds were found near State College, Pa. Watershed No. 1 is about 300 acres in area; its stream-gaging station is already in operation. This watershed is on School land; the next two, lying adjacent, are on State land. The Department of Forests and Waters built an exceptionally fine access road to the first weir so that construction was relatively swift and trouble free. Ready-mix concrete trucks were driven directly to the weir site and the concrete was chuted directly into the forms.

A second three-way cooperative study involved the Station and the Bureau of Water Supply of the City of Baltimore and Maryland's Department of Forests and Parks. The Bureau is interested in water-yield from its 18,000 acres of reservoir-bordering property. A research area was selected that contained four small watersheds, and by year's end two weirs had been built. Two of the watersheds are forested and two are recently planted fields with heavy riparian growth. Objectives are to determine the effect of present cover, and then the effect of removing the riparian growth and of different degrees of forest cutting. In this project, the city of Baltimore provided the lands, built the weirs, and will maintain them. The Department of Forests and Parks

will conduct the areal and timber surveys, and the Station will provide technical guidance and instrumentation.

Continued Measurement
Of Climate And Streamflow

In all, daily records of climate and streamflow were obtained at 15 watersheds during the year, up from 7 since 1954. Prospects of at least 8 more watersheds within the next 2 years, as planned extension of our present cooperative program, plus additional requests for cooperative studies, suggest the interest that is fast developing in this field of research. During the year, 11 papers were published and 7 others were submitted for publication.

--HOWARD W. LULL, Chief
Division of Watershed Management Research

Forest Insects

STATUS OF MAJOR PESTS

SPRUCE BUDWORM surveys conducted in cooperation with the Maine Forest Service showed a marked increase in severity of infestation in northern Maine. An appraisal of the situation there resulted in recommendations to spray about 300,000 acres in Aroostock County in the spring of 1958. The 1957 aerial survey of some 2,289,000 acres revealed defoliation as follows: heavy, 272,000 acres; medium, 707,000 acres; and light, 1,310,000 acres. Budworms populations and resultant feeding were heaviest where the infestation had been most serious in 1956. Aggregate parasitism of larvae and pupae was highest in the areas of light infestation and lowest in areas of medium and heavy infestation. Egg-mass populations, which indicate the potential infestation for 1958, were heaviest in areas most severely defoliated in 1956 and 1957. Parasitism of the eggs was low.

Pine sawflies continued to cause severe defoliation in several states in the region. The pine sawfly, Neodiprion pratti pratti, epidemic in Maryland on pitch and Virginia pine for the last 3 years, caused light to heavy defoliation of pine on about 1,500,000 acres. Some 1,200 acres of Virginia pine on the Beltsville Experimental Forest will be sprayed in 1958 to control this sawfly. Neodiprion pratti paradoxicus caused widespread defoliation of pitch pine and, to a lesser extent, shortleaf pine in southern New Jersey. Infestations of the European pine sawfly, N. sertifer, appear to be increasing in severity and extent in southern Connecticut and southeastern New York. Planted red, Scotch, and jack pines are being attacked.

Last spring, eggs of the red-pine sawfly, N. nanulus, were present in considerable numbers on approximately 2,000 acres of planted red pine in St. Lawrence County, New York; but expected heavy defoliation did not appear, apparently because of poor egg hatch. A 50-acre plantation of red pine in Saratoga County, New York, was sprayed by airplane with DDT for control of the red-headed pine sawfly, N. lecontei. This sawfly was unusually abundant in other localities in New York and western Maryland.

The white-pine weevil continued to attack high percentages of planted white pine in many areas. In one young

plantation in Groton, Conn., 90 percent of the trees were attacked. In Scotch pine plantations in Clarion and Centre Counties, Pennsylvania, 20 percent of the terminals were damaged. And on the Monongahela National Forest, where there is no nearby native or planted white pine, small scattered acreages of native red spruce, 20 to 40 feet tall, had 25 to 50 percent of the trees weeviled.

About 980 acres of infested white pine plantations in two areas in northern New York were sprayed in mid-April by airplane, receiving 4 pounds of DDT in 4 gallons of oil solution per acre. This was a pilot-plant test conducted jointly by the New York Conservation Department and the Forest Service under provisions of the Forest Pest Control Act. After spraying, weeviled trees averaged 6 percent in one area and 7.5 percent in the other--too high to be considered effective control.

The European pine shoot moth continued to cause serious damage to red pine in southern Connecticut and New York, northern New Jersey, Pennsylvania, Delaware, and northern West Virginia. Approximately 180 young red pine plantations were sampled in a statewide survey in Pennsylvania to determine extent of damage. Shoot moth infestations occur on some 250 of 8,000 acres of planted red pine on the Allegheny National Forest. In affected plantations, hand clipping of infested shoots has been recommended to prevent spread to all plantations. No effective chemical control of the shoot moth has been developed.

The pine tortoise scale, ordinarily not destructive in the Northeast, appeared in the spring of 1957 in outbreak proportions at Beltsville, Md., Shawnee State Park, Pa., and in Mineral County, W. Va. Later examinations during the summer in the three states disclosed that predation by the Coccinellids, Hyperaspis binotata and H. signata, and the Lepidopteron, Laetilia coccidivora, had controlled the scale in the areas where serious infestations were reported.

The gypsy moth infestation remained at a low level in New York and most of New England. In Maine and portions of Vermont and New York, low winter temperatures and late spring frosts were apparently responsible for a considerable reduction in gypsy moth populations. Egg-mass surveys conducted last winter in Connecticut revealed 60,000 acres heavily infested. Some 54,000 acres were sprayed in that state. Small acreages were sprayed in Maine and New York for gypsy moth control.

The large-scale Federal spray program directed by the Agricultural Research Service and aimed at eradication of the gypsy moth in the tri-state area of New York, New Jersey

and Pennsylvania was started on April 22 and completed on June 14. A total of 2,902,517 acres were sprayed by airplane with 2,484,494 gallons of 12-percent DDT solution. Other cooperative eradication spraying included 105,820 acres in Pennsylvania and 18,880 acres in Michigan.

The red pine scale, Matsucoccus resinosae, is still abundant in some plantations of red pine in the Bridgeport, Conn., area in spite of the fact that the Bridgeport Hydraulic Water Company has cut many trees in the most severely affected stands and low temperatures last winter caused heavy scale mortality. No surveys were conducted in 1957 to determine the spread of the scale in Connecticut. The only other known areas of infestation are on Long Island and in Westchester County, New York.

The fall cankerworm defoliated over 1,000 acres of oak woodland on Sugar Loaf Mountain, Maryland. In Warren, Maine, 1,000 acres were sprayed by airplane for control of this pest.

The pine leaf aphid, forest tent caterpillar, saddled prominent and variable oak leaf caterpillar infestations subsided in most areas in 1957. But there was an upsurge in infestation of the balsam needle gall midge, orange-striped oak worm, and pine spittle bugs in a number of localities

RESEARCH PROGRAM

The major insects involved in the research program were the white-pine weevil, gypsy moth, white-pine cone beetle, European pine shoot moth, pine tortoise scale, and old house borer.

White-Pine Weevil

Biology and ecology.--Studies showed that a substantial number of female weevils are inseminated in the fall and therefore are capable of laying eggs the following spring without further contact with males. In one white pine plantation in Connecticut it was found that 34 percent of the females had been inseminated in the fall. This information is important in planning spring spraying operations, for now it is known that a considerable number of females are ready to lay eggs immediately upon emergence from hibernation.

Studies of the sterilization of weevil adults with gamma radiation indicate that spermatozoa are more susceptible to irradiation than oocytes. At exposure of 2500

roentgens, substantial numbers of both sperm and eggs escape damage; but at 10,000 roentgens and above, a significantly higher percentage of spermatozoa than oocytes are damaged.

Laboratory and field tests with female weevils caged with white-pine twigs of varying bark thickness indicated that more eggs are laid and greater numbers of larvae mature in thick-barked twigs. Twigs with bark thicknesses less than 0.120 mm. contained significantly fewer eggs than twigs with bark thicknesses greater than 0.180 mm.

Studies were begun to determine if chemical elements in the tree determine susceptibility or resistance to white-pine weevil attack. Leaders of white pine and Norway spruce (susceptible species) and red pine and white spruce (non-susceptible species) were ground, and chemicals soluble in alcohol and ether were extracted. These extracts are now being tested to determine if any of them are attractive, repellent, or toxic to weevil adults.

Biological Control.--A preliminary test was conducted to determine whether overwintering white-pine weevil adults can be infected with the fungus, Aspergillus flavus. A heavy suspension of spores in water was applied to duff in which weevils were hibernating. Six lots of 20 weevils each were treated. Twelve weevils in one lot were affected and 6 in another. Weevils in the other lots were not affected. There is no apparent reason for the difference between lots.

Chemical control.--Early spring tests were made with low dosages of emulsion sprays of Lindane, Endrin, Heptachlor, and Malathion. The sprays were applied by a knapsack sprayer to white pine leaders. All tests gave excellent control of white-pine weevils as they emerged from hibernation and started feeding on the bark. One test of 1 percent Lindane plus the extender Aroclor 5460 applied in January gave complete control. And this past year it was also found that fall applications of Lindane plus extender were effective the following spring. Applications of 2.0, 1.0, and 0.5 percent Lindane plus equal parts of Aroclor were made in October 1956. Of 10,000 white pines treated with these dosages, only one tree was weeviled by mid-July 1957. In nearby unsprayed check plantations 25 percent of the trees were weeviled.

Applications of granular Endrin (2 percent), Aldrin (2 percent), Dieldrin (2 percent), and Heptachlor (2½ percent) at rates of 1, ½, and ¼ pound actual insecticide per acre, were made in the fall of 1956 to control hibernating weevils caged in the duff. Aldrin and Heptachlor at all dosages gave complete control. A field test is now under way in New York using ½ and ¼ pound each of Aldrin and Hep-

tachlor. These granular insecticides were applied with a rotary disk seeder to ¼-acre plots heavily infested with weevils.

Gypsy Moth

Larval rearing.--Large numbers of female moths are needed to supply the sex-attractant extract used to bait traps in gypsy moth detection surveys. Studies are under way to develop methods for the mass rearing of gypsy moths with minimum losses from virus diseases. Preliminary investigations indicate that many factors may be involved, including food, crowding, temperature, and humidity. The effects of these factors are being studied separately and in combination. The aim of the study is to develop techniques for the continuous rearing of gypsy moths in lots of five to ten thousand. Two walk-in sized rooms in which temperature and humidity may be controlled are being built at the New Haven Laboratory, not only for the gypsy moth rearing project but for studies of diseases of other forest insects in the region.

Polyhedrosis virus study.--Examination of diseased gypsy moth larvae gave indications of four types of mortality due to (1) virus alone; (2) virus and bacteria in combination; (3) bacteria alone, and (4) an unknown agent, isolated but unidentified.

Sterilization with gamma radiation.--At the Brookhaven National Laboratory, male and female gypsy moth pupae were exposed to gamma radiation at dosages of 2,500, 5,000, 10,000 and 20,000 roentgens. The adults that emerged from the irradiated pupae were mated, and eggs laid by the females are being held for later examination to determine what proportion are sterile. These studies are step one in determining whether the gypsy moth can be controlled by releasing sterile males.

Chemical control.--In an effort to find an insecticide as effective as DDT but one that will leave a less objectionable residue, Malathion and Methoxychlor at two dosage levels were applied by airplane to woodland plots in Connecticut. Based on occurrence of living larvae, frass drop, and defoliation following spraying in plots treated with Malathion and Methoxychlor, both insecticides were ineffective in eradicating the gypsy moth. In fact, there was some survival in plots treated with the standard DDT spray, 1 pound in 1 gallon.

Balsam
Wolly Aphid

Biological control.--Plans are being made for Philip B. Dowden to visit Japan in 1958. He will collect and send to this country and to Canada predators that might be used to combat the balsam woolly aphid here.

White-Pine
Cone Beetle

Chemical control.--Preliminary tests conducted in 1956 in applying Endrin and Lindane plus Aroclor with a mist blower for control of the white-pine cone beetle gave promising results. Applications of ¼, ½, and 1 pound per acre of Endrin and Lindane plus Aroclor were made on April 19, 1957, by helicopter in white pine stands in Alfred, Maine, to control the cone beetle. Sprays were applied at the time of beetle emergence from hibernation. Observations indicated that cones were protected from attack for a few weeks, but when final examination was made on August 26, nearly every cone was found to be infested with the beetle.

Pine Tortoise Scale,
Toumeyella numismaticum

Chemical control.--A spray containing 1 pound of Malathion in two gallons of fuel oil per acre was applied by airplane to 25-acres of heavily infested Virginia pine on the Beltsville Experimental Forest, Laurel, Md. Spray was applied 3 days after the first hatch of crawlers, and nearly complete control of the early hatching crawlers was obtained. Crawlers emerging about 1 week after treatment were unaffected by the spray but were almost completely eliminated by predaceous Coccinelid larvae. These predators, under female scales at the time of spraying, were not killed by the chemical. In a nearby unsprayed check area, the scale population was reduced to about 50 percent by the predator. By late summer most remaining scales in the check area were also destroyed by predators.

European Pine
Shoot Moth

Ecological studies.--Studies were initiated in 1957 on temperature-insect development relationships of the shoot moth. An attempt will be made to determine a cumulative temperature index for the appearance of different stages--pupae, adults, eggs, and the needle-mining stage--of the insect. It is hoped that such an index may facilitate the timing of sprays against the various insect stages so difficult to determine from field observations.

Red Pine Scale,
Matsucoccus resinosae

Winter mortality.--The week of January 18, 1957, was unusually cold in the area of Bridgeport, Conn. Temperatures dropped to -25°F. Examination of scales collected there showed heavy winter mortality in some plantations but not in others. Populations were substantially reduced, but probably not eliminated in any plantation. This information is important, for it gives some indication of the potential northern range of the insect should it spread into other areas where red pine occurs.

Pine
Sawflies

Virus studies.--In 1956, red pine plantations on property of the Stamford, Conn., Water Company were sprayed with a virus suspension to control the pine sawfly, Neodiprion sertifer. Examination showed that only a light, scattered infestation occurred there in 1957, while severe defoliation of pines occurred in adjacent unsprayed stands. Some 2,000 larvae of the red-headed pine sawfly, N.lecontei, collected in New York, were fed foliage sprayed with lecontei virus received from Canadian entomologists. Nearly 100 percent mortality of the sawflies resulted, but more than one pathogen was involved, and recovery of virus will be low.

Old House
Borer

Chemical control.--Oil solutions of 5 percent DDT and ¼ percent Dieldrin applied as brush treatments to artificially infested 2 x 4 inch pine blocks gave control of old house borer larvae after a period of 12 to 16 weeks. These chemicals, plus 2 percent Chlordane and ½ percent Lindane, were applied with a brush to floor joists and subflooring in infested houses. Apparently the borer was controlled, for its chewing stopped. It is believed that this type of treatment will be adequate for controlling the old house borer in many houses, thus avoiding more costly control by fumigation.

Survey Of Disease Organisms
In Forest Insect Pests In The Northeast

The major effort in 1957 has been isolation and storage of disease organisms. Fourteen isolations were made from the spruce budworm, 11 from the gypsy moth, 3 from the Nantucket pine tip moth, 1 from the European pine shoot moth, 4 from the Leconte sawfly, 3 from Neodiprion simile, 2 from

N. sertifer, 2 from the white-pine weevil, and 1 from the pine cone beetle--41 in all.

Improvement In Forest Insect Survey Techniques

Analysis of data from the white-pine weevil, Nantucket pine tip moth, and European pine shoot moth sampling studies was initiated. The inter- and intra-tree distribution patterns of the tip moth and shoot moth have been determined in terms of both insects and tip injury. Field data for this study were taken from a number of localities, representing a wide range of population densities. Similar sampling data of spruce budworm populations are also being analyzed.

A new sequential sampling plan for eggs of the red-pine sawfly, Neodiprion nanulus, was devised in cooperation with the New York State Science Service. The new plan is based on 6-inch twig, rather than 15-inch twig sampling units. Analysis of the field data indicates that the smaller unit is just as accurate as the larger, and also more practical for sampling in the field.

Frequency Distributions Of Forest Insects

Studies are under way of frequency distributions of forest insects and their relation to sampling, experimental design, population dynamics, and evolutionary trends. Data are being analyzed on Eriophyes (a mite), Nantucket pine tip moth, European pine shoot moth, spruce budworm, red-pine sawfly, and other insects. The first report on these studies will deal with the question of whether contagious distributions are sampling artifact or biological reality.

Training

Training sessions in forest insect detection for state field personnel were held in Maryland and New Jersey with Station entomologists participating. Special instructions for identifying and recording the occurrence of forest insect and disease damage were developed for field crews on the Forest Survey.

--RAYMOND C. BROWN, Chief
Division of Forest Insect Research

Forest Diseases

THE FOREST DISEASE situation has not changed materially during the year. The same diseases continue to damage forests, and though some vary in intensity and damage, most remain fairly constant. No epidemic outbreaks have occurred, but the endemic diseases have continued their insidious attack.

FOREST DISEASE SURVEYS

An extensive Station-wide survey of forest disease conditions was made during the year. Drs. Zabel and Silverborg of the New York State University College of Forestry at Syracuse were employed to conduct the survey. It has provided much information on forest diseases and will serve as a guide to our future research program.

Red Oak Dieback

During 1957, investigation of extensive mortality of red, black, and scarlet oaks in Pennsylvania, New York, and West Virginia was continued. Study emphasis was placed on rooting depth and soil relationships, effects of recent frosts, and possible relationships of previous frosts to mortality. Observations on extent and continued occurrence of oak mortality were pursued. Relationships of certain unidentified organisms to the mortality were also studied.

Trees dying of the disease during 1957 were those previously weakened. No new mortality areas were reported, in contrast to the 1956 reports of extensive new oak mortality in Pocahontas County, West Virginia, and in a few isolated locations in Pennsylvania. Studies in progress are inconclusive and no causal relationship has been definitely established.

Oak Wilt

No material extension of oak wilt occurred during the year. The disease was found in a few additional counties in

Pennsylvania and West Virginia, but the overall range has not changed. It was not found east of the three most westerly counties in Maryland, nor east of the Susquehanna River in Pennsylvania. Though oak wilt continues to be a major threat, control programs in the Northeast seem to be holding the disease in check.

Root Rot

Planting pure stands of a single host species creates the possibility of a bad disease outbreak. In the case of Fomes annosus, this may complicate the root rot picture of red pine. F. annosus, unimportant in natural stands, seems to be increasing in planted stands. In recent years, many northeastern plantations have reached the size for 1st and 2nd thinning operations when F. annosus appears. And reports of F. annosus damage have greatly increased during the past 5 years.

The New Haven Laboratory has cooperative Fomes annosus control plots in red pine plantings at the Harvard Forest, Petersham, Mass., and the Old Orchard Golf Course at South Hadley. Other experimental work with F. annosus is being conducted at Hillsboro, N. H., in cooperation with the Fox Forest.

Control plots are based upon the findings of Rishbeth, in England, who noted that painting freshly cut stumps with ordinary creosote gave about 90 percent control of new infections of F. annosus. Rishbeth also found that stumps infected by a saprophyte, Peniophora gigantea, were afforded about the same protection against F. annosus as when they were creosoted. But once infection does occur, the disease is spread from tree to tree by growth of the parasite through underground roots. Thus stump treatment prevents, or at least delays, spread from the original infection spot. If the disease is spread as indicated, apparently it will be worse in pure plantings than in mixed or natural stands.

The following observations were made on our control plots in young red pine plantations during 1957. At South Hadley, trees were cut on plots in January-February 1956, and at the Harvard Forest in mid-May 1956. In May 1957, a fungus was growing in the duff around many stumps at South Hadley. This fungus matted pine needles and duff material so that a doughnut-like incrusted mass surrounded stumps (fig. 16), both treated and untreated. The same condition, but to a lesser degree, existed on the Harvard Forest. During the May inspections, this growth had not been noted on the stumps but was limited only to the adjacent duff. However, by July a fungus that apparently originated from the

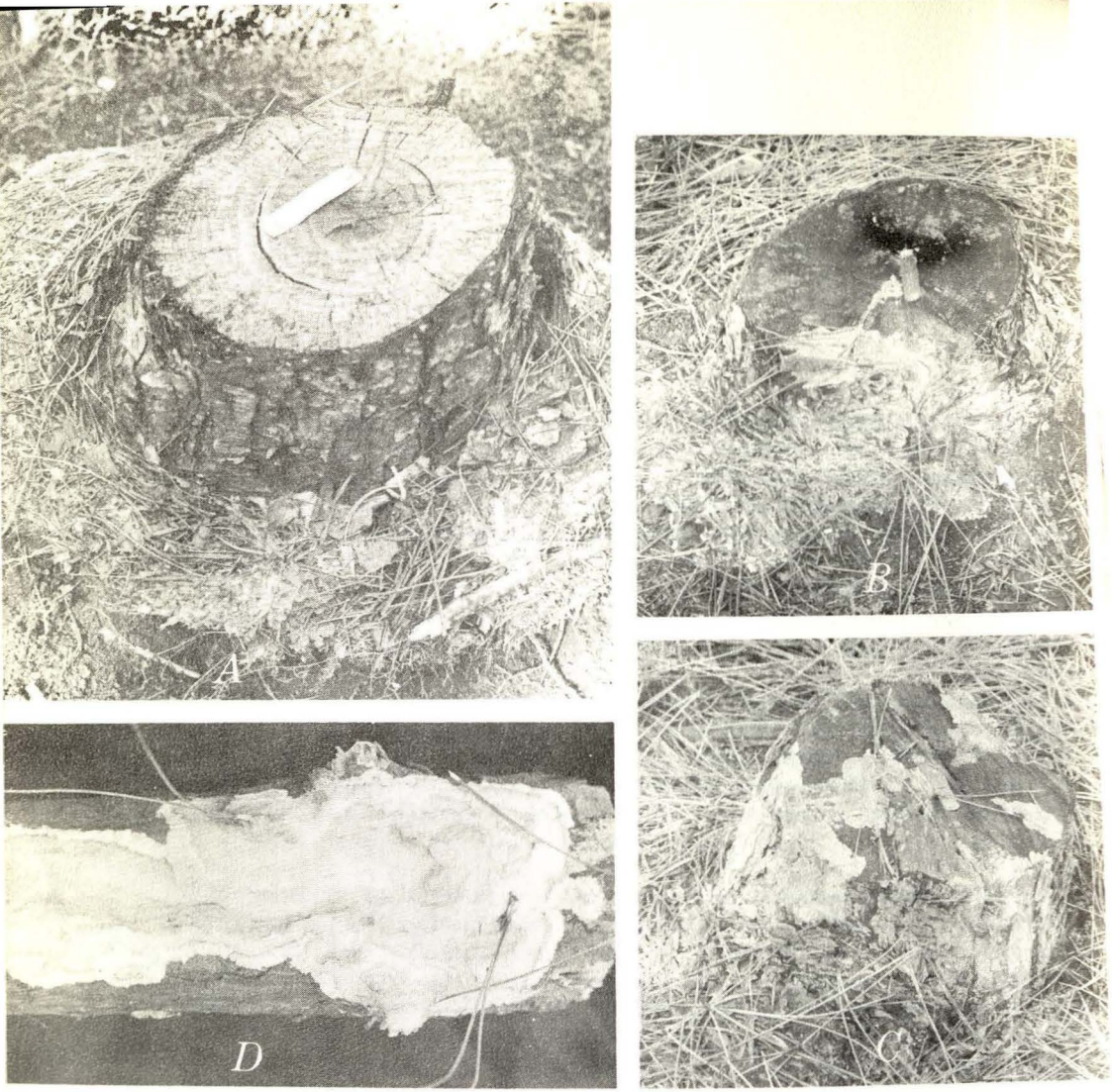


Figure 16.--*The "control fungus" that is believed to check* Fomes annosus. A, *one of the doughnut-like rings of fungus found in a red pine plantation in Massachusetts. The duff has been cleared away to show the ring around the stump.*

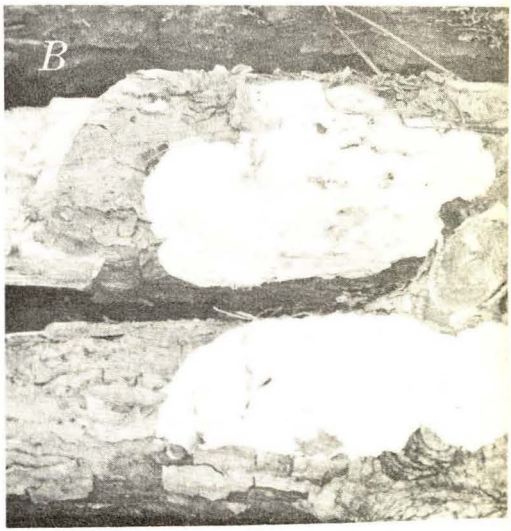
B, *the same fungus about 2 months later (July), growing over the bark and beginning to grow on the cut surface.* C, *by early October it was growing over the cut surface and had lost its waxy appearance and changed to a pinkish, gray-green, or mouse-gray color.*

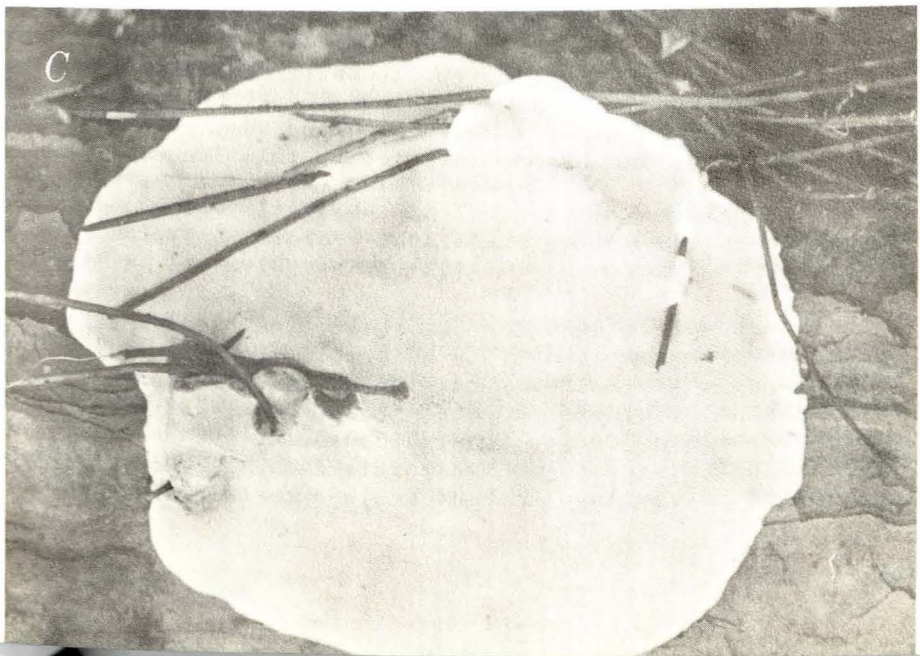
D, *the fruiting stage of the fungus, by which it was identified as* Peniphora gigantea. *It grows only on dead material and does not harm living trees.*

Figure 17.--*Wood piled near stumps infected by* Fomes annosus *may become infected with the fungus. A, typical fruiting bodies (conks) of the fungus, which usually grow about at the level of the duff and are partly hidden. The duff has been cleared away here to show them.*

B, *fruiting bodies of* F. annosus, *on red pine bolts that had been cut in the winter and piled during spring and summer on a spot that was infected with the fungus.*

C, *an enlarged view of the* F. annosus *resupinate sporophore, or fruiting body, about two-thirds natural size. Note the many small pores in the surface.*





matted duff was growing over the bark on the stump sides, and in a few cases, starting to grow on the cut surfaces of stumps. By early October, even more fungus grew on the top surface of the stumps.

During the fall, specimens of the fruiting stage of this fungus, collected for identification, proved it to be Peniophora gigantea. This is the same fungus that Rishbeth found effective in preventing F. annosus from becoming established on cut stumps in the red pine plantations. It thus appears that under suitable conditions some natural control occurs. This may complicate interpretations of the effectiveness of creosoting in our F. annosus control experiments. Analysis has not yet shown what percentage of stumps were colonized by P. gigantea, nor how untreated versus creosoted stumps compared in this respect. Perhaps time of cutting affects the amount of natural control by P. gigantea, though we have no information on this. Approximately 16 months elapsed between the time of cutting and the date this "control fungus" was first noticed.

Ordinarily the presence of F. annosus is indicated by the fruiting body or sporohores on infected stumps (fig. 17). These conks are usually formed at or near the top of the duff. At South Hadley, a bad infection spot known to have existed for several years was examined. Here dead and dying trees had been cut, and the changes in micro-climatic--increased light, higher ground temperatures, lower humidities, etc.--made finding conks of F. annosus somewhat difficult. Conk formation above ground was suppressed even though roots were badly infected and underground conks were present. However, during the winter dead tree cuttings had been piled in small ricks near the infected spot; and when these piles were examined in the fall of 1957, it was discovered that some bolts on and near the ground had numerous fruiting bodies on them. Instead of shelving out, these bodies were resupinate, or lying flat on the bolt. Similar ricks on uninfected spots were not diseased though only 100 to 200 feet from the known infected area. Thus wood piled too near diseased stumps may become infected by this fungus.

White Pine Blister Rust

Cooperative research on white pine blister rust conducted at the New York State University College of Forestry at Syracuse, now nearing completion should more clearly establish the relationship of the pycnial and the aecial stages of blister rust. Observations continue on selections of white pine exposed to rust infection. Some pines give promise of possessing inherent resistance to blister rust.

White Pine Durability

Another nearly completed cooperative study at the College of Forestry at Syracuse, is being made to establish the relative durability of white pine trees. Comparable blocks of wood from a number of white pines grown in a single locality have been exposed under controlled laboratory conditions to two rot fungi. The test stage is ended and data are being taken for analysis.

Preventing Decay Of Wood In Use

Soil covers under basementless houses continue to prevent decay in subfloor timbers. Some barrier materials have been in test for as long as 15 years, but most for from 4 to 10 years. Asphalt-covered papers, waterproofed laminated papers, and thin metal foils spread over the soil have reduced moisture condensation on timbers. No evaluation has been made of the service life of these materials in use.

Chestnut Studies

As a result of an article, "Know any old American chestnuts?" by Arthur Grahame in Outdoor Life Magazine, we have received nearly 800 letters from persons in 36 states, Canada, and Mexico, reporting American chestnuts. However, it is disappointing to find that so many people were confused by tree species. Some American chestnuts reported have turned out to be Asiatic chestnuts, horse-chestnuts, buckeye, pignut hickory, or even Kentucky coffee bean. Nevertheless, a number of American chestnuts over 8 inches in diameter have been located within the blight area.

During the year, scionwood from American chestnuts in 13 States was distributed to 75 cooperators for grafting onto established chestnut root stock. Resulting trees will be observed for evidence of resistance to chestnut blight.

A test is also being made to determine if radiation will induce blight resistance. Scions from American chestnuts, radiated by gamma rays at Oak Ridge, Tenn., or Upton (Brookhaven), N. Y., were grafted into the crowns of 60-year old Japanese chestnut trees. Only 30 successful unions resulted from over 900 grafts. (The heaviest dosages of radiation proved lethal to scionwood.)

"DEFECTIVE SPECIES"

There are a number of tree diseases that appear to be widely distributed and year after year the damage they cause remains fairly constant. The majority of butt and trunk rots of living trees are examples. While various tree species are more susceptible to decay than others, those most susceptible are often spoken of as "defective species". For example, it has been found that for balsam fir in natural stands, if the average ages or sizes of the trees are known, the amount of decay can be predicted quite accurately.

Tree rots, particularly rots of red maple, were studied at the New Haven Disease Laboratory during 1957. It seemed more profitable to work on defective species than on less susceptible ones. For the amount of rot and cull in defective varieties may be the prime factor in determining whether they can be economically utilized. If the number of diseased species could be lessened, it might well reduce the number of "inferior hardwoods" plaguing the Northeast.

Major objectives in such rot studies are to find out how much rot is present, how much can be expected to occur in stands in different localities and sites, and what external signs can be used in foretelling the amount of cull during timber cruises, marking, or cutting operations. What is the relation of size, age, and site to the amount of internal tree rot, and how can such information be used? Can the amount of rot be predicted from external indicators? Will it pay to cut those trees where a certain amount of rot may be present?

Rot studies of red maple at the Penobscot Research Center during 1957, and similar studies at the Adirondack Research Center the previous year, partially answered some of these questions. Although the current work has not been analyzed, red maples growing in wet, swampy sites were much more defective than those on better sites. Whether it will be feasible to harvest red maples from swamps is problematical, and may depend upon the amount of cull acceptable by local markets.

Certain red maple rot fungi fruit commonly and these fruit bodies--sporophores or conks--indicate the presence of internal rot (fig. 18). When studies are completed, it is expected that predictions can be made for the average amount of rot associated with these fruiting bodies. It was found, however, that the fungus causing, by far, the greatest amount of decay in red maple does not fruit on standing living trees, as did the fungi shown in figure 18. Still, this non-fruiting decay-producing fungus, Polyporus glomeratus, does produce sterile conks. These clinker-like, black,

Figure 18.--*Tree rots affect some trees more than others and this leads us to think of some trees as "defective species".*

Left, Fomes igniarius *fruiting body on a live red maple. Right,* Fomes connatus *on a live red maple. Presence of these fruiting bodies almost always indicates internal rot.*

incrustations look much like burnt toast; their presence invariably indicates rot within the tree. When more than one sterile conk is present, rot is extensive; and the internal rot column is usually continuous between conks. Sterile conks are usually found in connection with knots; and if the knots are closed or callused over, the conks will not be seen. But their presence is easily revealed by cutting into the suspected area.

Swollen knots are indicators of rot and cull, but they are very unreliable. Still, when rot is associated with swollen knots, cutting into them will expose the sterile conks of P. glomeratus, a sure sign that the tree contains rot (fig. 19). Usually over 50 percent of the swollen knots of red maple will have rot associations.

Drought Accentuates Disease Symptoms

Drought in 1957 greatly intensified symptoms of wilt and dieback diseases. The symptoms of a disease can mislead in judging disease incidence, abundance, or frequency. Usually the wilts, such as Dutch elm disease or Verticillium, are much more conspicuous during hot, dry weather. As a result, these diseases appeared more severe and more abundant than usual. But were they actually more abundant, or were they just more easily recognized under such conditions? With

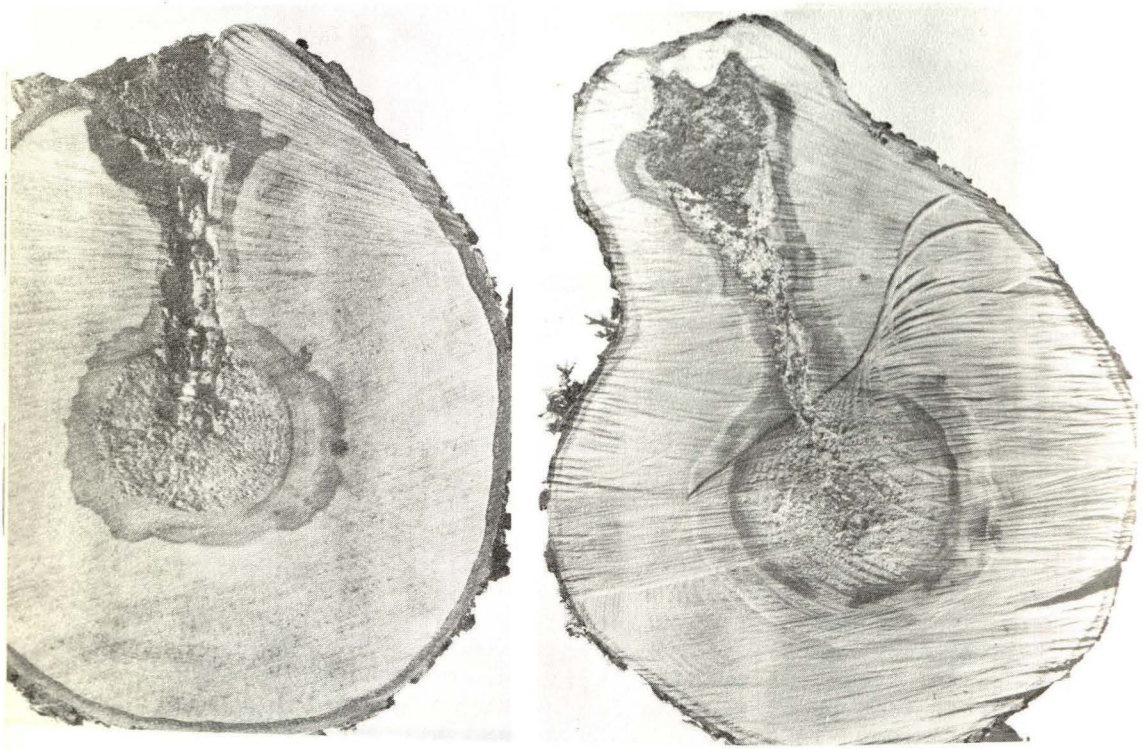


Figure 19.--*Swollen knots often indicate rot and cull, though the internal rot may be hidden.*

Left, cross-section of a live red maple infected by Polyporus glomeratus. *The knot cavity is plugged by a black and cinder-like sterile conk.*

Right, in this case the swollen knot has completely overgrown the sterile conk. Also P. glomeratus *on live red maple.*

Verticillium wilt, it may be the latter; but with Dutch elm disease, other factors must be considered. For example, this disease is spread by bark beetles, and drought conditions may favor beetle attack, especially if the drought coincides with the right stage in the beetle's life cycle. In such a case, the incidence of disease would be increased, and also more cases of the disease would be recognized due to the intensification of symptoms.

Applying the same line of reasoning to dieback troubles, severe drought not only may be instrumental in killing trees, but may also weaken trees so that secondary parasites become important. Weak pathogens unable to gain a foothold where growth is vigorous attack drought-weakened trees and produce dieback. It is not surprising that 1957 was a bad dieback year. The apparent abundance of bleeding canker of sugar maple may stem in part from the drought. Once established, weak parasites may continue to thrive, so that the dieback conditions of 1957 may be evident for several years to come. We expect that many inquiries and reports of disease will result from conditions induced by the 1957 drought.

--MARVIN E. FOWLER, Chief
Division of Forest Disease Research

Forest Economics

THE STATION'S economics research program includes Forest Survey and resource economics. The Survey of Northeastern forests provides information on quantity and quality of timber; knowledge of timber growth and mortality; and data on timber currently being cut from the region's forests. Such information is compiled by complete states and parts of states. It is used by forest industries in their search for raw material; it is also applied by public agencies and private concerns in planning forestry programs.

Our resource-economics research during 1957 was designed to provide information that will help forest landowners grow and sell timber more efficiently. Such data also help legislators and public and private foresters develop programs to encourage greater efficiency in growing, processing, and marketing timber products.

FOREST SURVEY

Forest Inventory

Progress in 1957 brought us to within 6 million acres, or 7 percent, of completing the initial survey of forests of the Northeast. Field work was completed in Delaware and on an additional 4,447,000 acres in Maine. Thus, inventory has been concluded in all of the twelve Northeastern States except Maine, where about one-third of the forested land remains to be surveyed. With aerial photos now available for this final area, we anticipate completing the initial Maine survey in 1958.

During the year, inventory crews covered one of the country's most difficult survey areas--northern Maine. Crews drove jeeps fairly close to the most accessible plots. But to reach forest plots along the Allagash and St. John Rivers, they had to use canoes. In other areas the crews were flown in, surveying plots within a walking distance of lakes on which their plane could land. Despite these handicaps, crews made good progress. This was due to enthusiasm of crew members, and also to the advice and assistance given them by State and industrial foresters.

But Maine was no exception, for in Delaware and other states as well, we have been able to conduct the Survey efficiently because of the cooperation of private forest industries and state agencies. For example, the aerial photos loaned us by cooperators made it possible to use the latest methods of stratified sampling; in turn, this enabled us to speed our field work and improve the accuracy of our inventory estimates. This year aerial photographs were furnished by the Delaware Forestry Commission, Oxford Paper Company, Great Northern Paper Company, the Maine Bureau of Taxation, and the Maine Forest Service.

This fall final arrangements were made with a number of forest landowning companies for a cooperative forest growth study in southern and central Maine. Periodically the companies will re-measure inventory plots originally established by Survey crews. The Station will train those who will re-measure the plots and will analyze the data collected. These re-measurement data will provide greatly improved growth estimates for the area and for the stand conditions specified. Then too, relatively current inventory data will also be provided. The first re-measurements are scheduled for 1958. (The Station has been cooperating for several years with a number of companies on a similar growth study in Northern Maine.)

Timber Cut

In addition to inventory data, we estimate the volume of timber cut in each state for the same year the inventory is taken. To make these estimates, we obtain data on the volume of lumber and other primary forest products produced. Studies of local utilization practices on logging operations indicate how much tree volume is required, on the average, to produce each thousand board feet of lumber, each ton of pulp, each cord of firewood, and so forth. By applying these conversion factors to the product-output data, we arrive at the timber-cut estimates.

During 1957, utilization studies were completed and appropriate conversion factors were developed for New Jersey and Delaware. Timber-products output and timber-cut estimates were made for these states. Studies of utilization practices in Maine were continued.

Techniques Research

Conducting an efficient forest survey has presented a continuing challenge: each year more detailed data have been requested; costs have risen; improved survey techniques have

been developed. We have tried to keep abreast of these developments, but each year the problems have become more complex. Moreover, as our initial survey nears completion, we are faced with revising our techniques to a system appropriate for re-survey.

This year, to meet this challenge of readjustment, we started a full-time program of research in forest-survey techniques. Studies now under way include a comparison of the current canvass system of estimating timber cut with one based on use of aerial photos and ground plots. The use of strips of aerial photos rather than complete coverage is also being studied. In addition, we are making an analysis of the costs and relative advantages of different kinds and scales of aerial photos.

In 1956, we re-measured 100 forest-survey plots in New Hampshire that had first been measured in 1946-48 during the initial survey. Careful analysis of these data confirms our thought that such re-measurements would provide reliable growth estimates as well as volume data at relatively low cost. The analysis has also been helpful in showing what safeguards must be taken in re-measuring plots if the desired results are to be achieved. This study will be invaluable in planning our re-survey procedures.

Additional data were collected on the relationship of stump diameter to diameter at breast height for several major species. Eight research notes on stump-d.b.h. relationships have been published, the latest for white oak. This information will be helpful in ground survey estimates of timber cut. It has also proved very valuable to foresters called in after timber cutting to determine the volume of timber removed.

In cooperation with the Pennsylvania Department of Forests and Waters and Pennsylvania State University, we are preparing volume tables for the major timber species in Pennsylvania. In addition to providing valuable new volume tables, this is a study of methods of volume table construction.

RESOURCE ECONOMICS

Resource-economics research during the year included analysis of timber resources in states where the Forest Survey has been completed, and studies of the economic aspects of various timber-growing and marketing alternatives.

Resource Analysis

Analyses of data collected by the Forest Survey resulted this year in two published reports: "The Timber Resource of Rhode Island" and "The Timber Resource of Connecticut." These give summaries of forest area, timber volume, annual growth, timber cut, and other forest data for each state. Similar reports for Pennsylvania, New Jersey, and Delaware will be published in 1958. It was interesting to find that even in the Northeast's most densely populated states, a large part of the land is forested. For example, we found that 64 percent of Rhode Island and almost 50 percent of New Jersey is forest land.

The current rate of increase in timber inventory (growing stock volume) in these states is also interesting:

State	Ratio of Growth to Cut
Connecticut	7.6
Delaware	1.5
New Jersey	3.9
Pennsylvania	3.8
Rhode Island	6.5

True, most of this growth is on small hardwood trees, whereas the cut comes from larger trees. But with effective management these small hardwoods could eventually provide the basis for considerable expansion of the region's forest industries. This means more jobs, higher incomes, and a healthier economy.

Based on data from Forest Survey and other sources, an analysis of timber production alternatives in Pennsylvania is being prepared. This economic study compares the costs of expanding timber production by planting, cull-tree removal, cleaning, and thinning in Pennsylvania's forests. The usual problems of timber production on different sites and in stands of different densities and species compositions have to be faced. But also considering such things as timber quality, price differentials between species, and price trends has made this analysis a complex one. Completion of the study is expected in early 1958. The results should be directly applicable in planning public forestry programs, and will be of interest and help to industrial foresters.

Marketing

Foresters frequently wonder, "Should this log be cut into lumber, or would it be more profitable to sell it as pulpwood?" And sawmill operators ask, "How much more is

this clear log worth to me than that knotty one?" To answer these and similar questions, tentative log grades for eastern white pine were developed and tested this year at four sawmills in southern Maine. With the cooperation of several additional mills next year, the preliminary testing should be completed and the log grades will be made available for general use.

White pine is the region's most important lumber species. We knew that important changes had been taking place in its markets. For example, we knew the market for white pine for boxes has greatly declined in recent years, and that the importance of knotty pine grades has certainly increased. We knew more mills were selling graded lumber; fewer were selling round-edge material. But we wanted to learn the extent of these changes and what further ones are likely to develop. To find the answers and to analyze the effects of these developments on the industry and on timber growers, a study of the market structure for white pine lumber was undertaken in cooperation with the University of New Hampshire. The results of this study will be available in 1958.

With the advent of the backyard barbecue pit and the discovery of an outdoor chef in almost every family, considerable interest has developed in another forest product--charcoal. So, early in 1957, a survey of the region's charcoal manufacturers was made to answer such questions as: How much charcoal is produced in the region? What species of wood are preferred? How is the industry organized? Is it expanding? The results of the survey were published in a Station Paper, "Production and Sale of Charcoal in the Northeast."

The Station continued its active participation in a cooperative marketing study with eight of the region's agricultural experiment stations. This year the study dealt with the timber-buying practices of sawmills, and with the adequacy of available forest-product market information facilities. At year's end, the data were being summarized in preparation for a regional report.

Production Economics

There are more than 40,000 acres of idle farm land in Potter County, Pennsylvania. Agricultural economists at Pennsylvania State University have been studying the possibilities these idle fields offer for crop and pasture uses. But what about forestry? At the request of these researchers, we analyzed the forestry investment opportunities, selecting red pine and larch sawtimber, spruce pulpwood, and Scotch

pine Christmas trees as examples. A bulletin comparing crop, pasture, and forest uses for these tracts is planned for 1958.

Late in the year, as data became available from studies in the Lake States, Washington, D.C., and our own region, we started a comprehensive economic analysis of white pine management in the Lake States. Conclusion of this study is scheduled for 1958. It will provide economic guides for blister-rust and weevil control as well as for thinning and pruning in stands that differ in species, composition, age, site, and rust-hazard conditions.

Making full use of data collected in other studies without spending a great deal of time searching the literature is always a problem for researchers. In developing work-performance data for various forestry operations under different conditions, we wanted to make sure we didn't repeat research already completed by others. So in cooperation with the Yale School of Forestry, a careful review of publications is being made. The resulting bibliography will be placed on punch cards and classified so that one can quickly determine what other researchers have done in studying the costs of performing any particular forestry operation. Work on this project at New Haven is continuing, with current emphasis on logging costs.

--CARL H. STOLTENBERG, Chief
Division of Forest Economics Research

Forest Utilization

IN CONSIDERING the Station's forest utilization research effort, it should be kept in mind that our activities here are somewhat different from those in other research fields. Primarily, this is because for nearly half a century basic wood-utilization studies have been carried out at the U.S. Forest Products Laboratory, Madison, Wis. As a result, the Station's Division of Forest Utilization Research has been concerned less with basic utilization studies and more with analysis and planning, and application research.

Although the broad outlines of Division activities have changed little over the years, the program balance has varied considerably from year to year in response to a changing economy. For example, in the early years the emphasis was on helping a traditionally conservative industry adopt basic technological improvements, especially in logging, sawmilling, and seasoning. Problem analyses of individual situations and consultations at the plant level were among our first activities.

Main Fields Of Current Interest

Now the situation--and the current FUR program--has changed. As a result of the wave of modernization that FUR helped swell, there has been widespread and rapid acceptance of advanced processes and installation of modern equipment. Consequently, our present concern is with the orientation of industry to this new technology. More and more, the emphasis is shifting to coordinating and clearing research and research-based developments. Although there is industry-wide ferment from pulp to pallets, new or expanding fields emerge from time to time that demand special attention. One such headliner was--and still is--hardwoods for pulp; another was the substitution of wood for rags in roofing felt; possible use of wood molasses as stock feed, another. Currently, the four most prominent fields of utilization development are charcoal production, timber quality, use of or elimination of mill residues, and mechanization.

Obviously, these four fields are not comparable either in character or importance; but they are the areas

where our attention is focused at this time. Charcoal production, basically a simple process, is important because it is one of the few fields in which enterprisers with limited capital can operate profitably. Also, because it can use raw material of an indiscriminate type, charcoal production makes no demands on the scarce "quality" elements of forest yield and offers a fine opportunity for forest-improvement practices.

The field of timber quality, on the other hand, is all-embracing. Its fundamental concepts must be developed and understood and adequate tools for measuring and recording it must be forged if the orderly progress of the wood-based industries is to continue. To designate the use of or elimination of mill residues as a technical "field" is but a temporary expedient. Actually, this is a phase of a movement in which primary plants are (1) converting from single product (lumber) to multiproduct (lumber, chips, fertilizer, pallets, veneer) operations and (2) achieving full utilization of the forest yield. Mechanization, with accompanying opportunity for automation, is a must if the forest-based industries are to survive. And the battle for survival is being waged not only in the field of marketing, but also in production. The back-breaking days with a large labor force in the woods and at the sawmills are over.

A Division "On The Move"

Against this background, FUR during the past year continued to help industry meet an objective: the permanent, profitable, and proper use of forest yield. On both a local and national level, our utilization staff worked closely with individuals and groups interested in the expanding technology. Our activities led to progress in the research application field, and also to an opportunity for the conferences and discussions necessary to problem analysis and programming of research effort. In some instances, Division personnel played a leading role (for example, program chairman of a conference); in others, we operated in a secondary capacity (round-table discussion). The following are some of the major efforts of the Division of Forest Utilization Research:

- An industry-leader conference on more complete wood utilization, in cooperation with the New England Council.
- A national convention of the Forest Products Research Society.
- The Third Northeastern Logger's Congress, in cooperation with the Northeastern Loggers' Association.
- A charcoal producers, marketers, researchers conference,

in cooperation with Northeastern Wood Utilization Council.

- Two meetings of a kiln-drying association, in cooperation with the Northeastern Kiln Drying Association.
- Five timber-grading workshops, in collaboration with Forest Economics.
- Editorial services in logging engineering and machinery for the Northeastern Logger, in cooperation with the Northeastern Loggers' Association.

Secondary activities included participation in two conferences on sawmilling improvements on two occasions (ASME, SAF), Forest Production Clinic (Harvard), Wood Pallet Production Conference (Syracuse), student orientation conferences (Penn State, Yale), Small Sawmill Clinic (Syracuse), Residue Use Panel (NELMA), Forestry Field Day (N. H. Extension Service), and activities of the Northeast Section, Forest Products Research Society.

In addition, the following specific jobs were undertaken by Division personnel: preparation of a bibliography of recent literature on logging; participation in national log and tree grade problem analysis project; and preparation of a plan for the integrated operation of a forest property in West Virginia.

Further, our FUR staff studied the general trend of utilization in the region. It is interesting to note that in the midst of a business breather, the rapid modernization shift of primary industries continues. We observed the operation of typical installations of the Region's 30 gang mills, 15 automated sawmill carriages, 100 log and slab debarkers, 10 residue chippers, 100 charcoal kilns, and all the mobile and stationary equipment needed to keep these installations supplied with raw material and running. We kept in touch with the research of the Forest Products Laboratory and of other agencies. Particularly noteworthy was the opening of the Hugh P. Baker Memorial Forest Products Laboratory at New York State University's College of Forestry--an event that, in the future, will profoundly alter the utilization research picture, not only in the Northeast, but throughout the country. Partly in connection with ICA's training program, FUR gave assistance to foreign visitors from Liberia, Finland, Australia, Sweden, and Brazil. And, as in past years, in the course of our activities, FUR provided technical advice to several hundred individuals on a vast range of subjects.

--CHARLES R. LOCKARD, Chief
Division of Forest Utilization Research

Publications

in 1957 by staff members and cooperators of the Northeastern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture.

*Abbott, Herschel G., and Cunningham, Frank E.
1957. IS HARDWOOD NURSERY STOCK AVAILABLE? Northeast. Forest Expt. Sta. Forest Res. Note 70. 4 pp.
Nurseries have grown relatively little hardwood planting stock in the past; but a survey (112 nurseries, 32 hardwood species) indicates that, given the demand, nurseries could supply large volumes of hardwood planting stock.

*Banks, W. G., and Fenton, R. H.
1957. PRIMACORD TESTED FOR BLASTING FIRELINE. U. S. Forest Serv. Fire Control Notes 18: 164-167, illus.
Tested in pine-hardwood stands in Maryland, Primacord detonating fuse (50 grain per foot), failed to make satisfactory firelines. It started fires in hardwood litter.

*Barr, Carl R.
1957. SELLING SAFETY TO WOODS WORKERS.
Northeast. Logger 6 (2): 33, 70-71, illus.
Describes the logging operations on the Fernow Experimental Forest in West Virginia and the safety training given to logging crews.

Beebe, C.W., Rogers, J.S., Happich, M.L., and Simmons, F.C.
1956. DESTRUCTION OF TANNIN DURING CHEMICAL DEBARKING OF OAK TREES. Jour. Amer. Leather Chem. Assoc. 51 (6): 266-270.
Debarking oak trees by girdling and treating with sodium arsenite causes a loss of about 50 percent of the tannin in the bark. The loss may be due to loosening of the bark and subsequent weathering rather than the nature of the chemical used.

*Bickford, C. A.
1957. CONVERTING FACTORS FOR STACKED WOOD.
Northeast. Forest Expt. Sta. Forest Res. Note 69. 3 pp.
Offers a method (and table of conversion factors) for converting from or to the standard cord and other units

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*Copies or reprints available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

of measure used in the Northeast: units of 50-inch, 52-inch, and 60-inch bolts; and rough or peeled, round wood or split.

*Bickford, C. A.
1957. CONVERTING FACTORS FOR STACKED WOOD. (REVISED.) Northeast. Forest Expt. Sta. Forest Res. Note 72. 3 pp.
See above. Data revised because factor reported for converting peeled round cords into rough round cords was found to be too small.

*---------- et al.
1957. STOCKING, NORMALITY, AND MEASUREMENT OF STAND DENSITY. Jour. Forestry 55: 99-104.
Report of Society of American Foresters Committee on Stocking. Discusses concepts of stocking and measurement of stand density, and research needed to fill gaps in present knowledge.

*Cash, Edith K., and Waterman, Alma M.
1957. A NEW SPECIES OF PLAGIOSTOMA ASSOCIATED WITH A LEAF DISEASE OF HYBRID ASPENS. Mycologia 49: 756-760.
Plagiostoma populi was discovered in a plantation of hybrid aspens near Petersham, Mass. Hybrids attacked most severely were those that had been badly infected by Cibor-inia whetzelii in spring and early summer.

Connola, D. P., Waters, W. E., and Smith, W. E.
1957. THE DEVELOPMENT AND APPLICATION OF A SEQUENTIAL SAMPLING PLAN FOR FOREST TENT CATERPILLAR IN NEW YORK. N. Y. State Museum and Sci. Serv. Bul. 366. 22 pp., illus.
Describes a system of egg-mass sampling to predict extent and degree of defoliation by the insect the following season. Ten cut twigs per tree were used as a sample. Tests showed that the method effects considerable savings.

*Cunningham, Frank E.
1957. A SEED KEY FOR FIVE NORTHEASTERN BIRCHES. Jour. Forestry 55: 844-845, illus.
The nutlets of yellow birch, sweet (black) birch, river birch, paper birch, and gray birch are not easy to identify. The author offers a seed key that has proved useful for making identification.

Diller, Jesse D.
1957. IS OUR AMERICAN CHESTNUT DEVELOPING BLIGHT RESISTANCE? North. Nut Growers Assoc. Ann. Rpt. 47: 29-31.
Scattered individual American chestnut trees that apparently have survived the blight--some within blight-swept areas--are being studied in a search for blight-resistant strains. Reports on such trees are asked for.

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1957. TESTING AMERICAN CHESTNUTS FOR BLIGHT RESISTANCE. Northeast. Forest Expt. Sta. Forest Res. Note 74. 3 pp., illus.
Reports locations of living American chestnut trees reported by over 600 people in 36 states, and outlines plans

for testing some of these trees for blight resistance.

*Diller, J.D., Whittaker, C.W., and Anderson, M.S.
1957. LONG-TERM RESPONSE OF OLD JAPANESE CHESTNUT TREES TO FERTILIZER. Jour. Forestry 55: 299-300.

Fertilizer was applied to 50-year-old Japanese chestnut trees in 1944-45. Observations made 2 years later showed no effect. But observations made in 1955 showed significant increase in d.b.h. growth.

*Dowden, Philip B.
1957. BIOLOGICAL CONTROL OF FOREST INSECTS IN THE UNITED STATES AND CANADA. Jour. Forestry 55: 723-726.

Entomologists are turning more and more attention to the use of parasites, predators, and virus diseases for controlling harmful forest insects. Discusses past and present work and outlines research work needed.

*Eschner, A.R., Jones, B.O., and Moyel, R.C.
1957. PHYSICAL PROPERTIES OF 134 SOILS IN SIX NORTHEASTERN STATES. Northeast. Forest Expt. Sta., Sta. Paper 89. 23 pp., illus.

Mechanical analysis, organic-matter content, plasticity, bulk density, and soil-moisture contents at saturation and full capacity are given for 134 soils in the six Northeastern States from Pennsylvania to New Hampshire.

*Ferguson, Roland H., and McGuire, John R.
1957. THE TIMBER RESOURCES OF RHODE ISLAND. Northeast. Forest Expt. Sta. 38 pp., illus.

The forest survey of Rhode Island disclosed that two-thirds of the State's land area is forested. Very little sawtimber is available, yet other forest uses--recreation and watershed uses--give great value to the forest resource. Data on volume, growth, cut, products, forest area, species, ownership.

Fowler, Marvin E.
1956. WHERE WE STAND NOW IN TREE DISEASE RESEARCH. Arborist's News 21 (11): 81-86.

Outlines economic importance of forest tree diseases and the work of Federal pathologists in detecting and controlling diseases.

1957. CURRENT STATUS OF SOME IMPORTANT TREE DISEASES. Northeast. Logger 6 (2): 41-43, illus.

Describes the major tree diseases and the research work being done to combat them, with special reference to the economic loss caused by tree diseases and its importance to the lumberman.

*Godwin, P. A., Jaynes, H. A., and Davis, J. M.
1957. THE DISPERSION OF RADIOACTIVELY TAGGED WHITE-PINE WEEVILS IN SMALL PLANTATIONS. Jour. Econ. Ent. 50 (3): 264-266.

Study shows that the weevils fly well and frequently, and movement of 724 feet is a certainty. Materials and methods described. Authors suggest that experimental plots should be at least 800 feet from infested areas.

Grisez, Ted.
1957. DEER BROWSING IN THE POCONOS.
Pa. Game News 28 (2): 7-10, illus.
Shows dramatic comparison of tree reproduction inside and outside a deer-proof enclosure. Deer browsing increased low-value species such as beech and striped maple at the expense of more valuable species.

*
Griswold, Norman B., and Ferguson, Roland H.
1957. THE TIMBER RESOURCES OF CONNECTICUT.
Northeast. Forest Expt. Sta. 37 pp., illus.
Report on findings of the forest survey in Connecticut: statistical data, and an analysis of the forest situation. Forest area, ownership, forest types, timber volumes, growth, cut, and timber-products output.

*
Hahn, Glenn Gardner.
1957. A NEW SPECIES OF PHACIDIELLA CAUSING THE SO-CALLED PHOMOPSIS DISEASE OF CONIFERS. Mycologia 49: 226-239, illus.
Description and life history of the new species Phacidiella coniferarum, with unpublished cultural data regarding its imperfect or Fhacidiopycnis Poteb. stage, which previously had been described as a Phomopsis.

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1957. PHACIDIOPYCNIS (PHOMOPSIS) CANKER AND DIEBACK OF CONIFERS. U. S. Dept. Agr. Plant Disease Rptr. 41: 623-633, illus.
The canker-dieback disease of Douglas-fir, larch, and other conifers--formerly known as Phomopsis--is now known to be caused by a wound parasite, Phacidiopycnis pseudotsugae (M. Wils.) Hahn. Description of parasite, natural infections, inoculation results, damage, and control.

*
Hampf, Frederick E.
1957. RELATIONSHIP OF STUMP DIAMETER TO D.B.H. FOR PITCH PINE IN THE NORTHEAST. Northeast. Forest Expt. Sta. Forest Res. Note 65. 3 pp., illus.
Stump diameter-d.b.h. relationships for pitch pine were worked out from data gathered on logging operations. Presented in graph form, these relationships are expected to give reliable d.b.h. estimates for pitch pine in Northeast.

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1957. RELATIONSHIP OF STUMP DIAMETER TO D.B.H. FOR WHITE OAK IN THE NORTHEAST. Northeast. Forest Expt. Sta. Forest Res. Note 66. 4 pp., illus.
Stump diameter-d.b.h. relationships for white oak were worked out from data gathered on logging operations. Presented in graph form, these relationships are expected to give reliable d.b.h. estimates for white oak in Northeast.

*

1957. PRODUCTION AND SALE OF CHARCOAL IN THE NORTHEAST. Northeast. Forest Expt. Sta., Sta. Paper 100. 14 pp.
Report on a survey of charcoal production in the Northeastern States: quantities produced, equipment used, wood consumed, charcoal yield, markets, prices, and types of

buyers. List of producers by states.

Harper, V. L., Frank, Bernard, and McQuilkin, W. E.
1957. FOREST PRACTICES AND PRODUCTIVITY. In Soils, U. S. Dept. Agr. Yearbook 1957: 732-741.

Four forest practices are related closely to soil productivity: prescribed and controlled burning, monoculture (growing a single species in pure stands), grazing by livestock, and harvesting commercial timber. Burning, grazing, and harvesting, if not properly done, may destroy or alter the organic material, compact the soil, and cause erosion.

Hart, Arthur C., and Tuttle, Harold B.
1957. A NEW WRINKLE IN CHEMICAL DEBARKING. Northeast. Logger 6 (1): 16.

Sodium arsenite treatment does not completely loosen all bark on a tree; so as soon as the tree is felled, slit the bark on top of the trunk with an ax, and let the tree lie for several weeks. The bark will shell off.

*Holcomb, Carl J., Weitzman, Sidney, and Hutnik, Russell J.
1957. FARM WOODS MANAGEMENT AT THE MOUNTAIN STATE RESEARCH CENTER. A 5-YEAR REPORT. Va. Polytech. Inst. Agr. Ext. Serv. Bul. 251. 18 pp., illus.

Two 30-acre tracts managed as farm woods (using the type of equipment available to farmers) yielded almost 80,000 board feet of salable material in five annual cuttings that also improved the woods vastly.

Hough, Ashbel F.
1957. PIONEER TREE PLANTER. Pa. Forests 37 (4): 88-90, 105-106, illus.

A historical sketch of the family, life, and times of Franklin R. Miller, one of the pioneer tree planters in Pennsylvania. His plantings on the Miller farm near Sugar Grove, Warren County, Pa., are now more than 100 years old.

1957. THE RED PINE PROVENANCE TEST ON THE KANE EXPERIMENTAL FOREST. Northeast. Forest Tree Improve. Conf. Proc. 4: 3-5, illus.

A test plantation was started in 1937 with stock representing 50 different seed sources. Significant differences in growth (based on 10-year measurement) led to recommendation of seed sources to be used.

1957. MARKING. (SAMPLE PLOT ON WOLF RUN EXPERIMENTAL FOREST.) Northeast. Forest Tree Improve. Conf. Proc. 4: 24-25.

Explains basis and objectives of silvicultural marking on demonstration plot in Allegheny hardwood stands, as part of symposium on marking.

*Hutnik, Russell J., and Weitzman, Sidney.
1957. GENTLE-GRADE ROADS MEAN FASTER SKIDDING. Northeast. Forest Expt. Sta., Forest Res. Note 71. 3 pp., illus.

Studies of experimental logging operations in West Virginia show that average skidding speed over a given dis-

tance is faster on gentle slopes of 5 to 15 percent (downhill with the load) than on the level or on steeper grades.

*Jaynes, H. A., and Godwin, P. A.
1957. STERILIZATION OF THE WHITE-PINE WEEVIL WITH GAMMA RADIATION. Jour. Econ. Ent. 50: 393-395.
Dosages of 5,000 to 10,000 r (Co^{60}) seemed best for sterilizing weevils. Of the insect activities studied, oviposition was the most drastically affected.

Jensen, Victor S.
1957. THE BARTLETT EXPERIMENTAL FOREST.
Northeast. Logger 5 (11): 24-25, 66-67, illus.
Outlines the history of this 2,600-acre forest in New Hampshire and the various types of forest-management research now being conducted there.

*Larson, Edwin vH.
1957. WHAT IS GRAMMAR, ANYWAY?
Soc. Tech. Writers and Editors Jour. Summer 1957: 9-12.
A liberal definition of English grammar, based on linguistic principles. Outlines Latin and Teutonic elements in English, difference between accidence and syntax, danger of jargon, and importance of tone and punctuation.

Lewis, F. B.
1957. TWO NEW SPECIES OF CERATOPOGONIDAE (DIPTERA).
Psyche 63 (2): 46-49.

*Little, S., and Mohr, J. J.
1957. GROWTH AND MORTALITY OF RESIDUAL LOBLOLLY PINES AFTER A SEED-TREE CUTTING. Northeast. Forest Expt. Sta. Forest Res. Note 75. 4 pp.
Study in Maryland indicates that, to prevent loss in volume, seed trees should be removed as soon as they have served their purpose.

*---------- and Mohr, J. J.
1957. SEEDBED TREATMENT INCREASES DOMINANCE OF NATURAL LOBLOLLY PINE REPRODUCTION. Northeast. Forest Expt. Sta. Forest Res. Note 76. 4 pp.
Results of a 5-year study in Maryland. Describes treatments that increased pine reproduction, stocking, and early height growth. Costs of seed-tree cutting and summer burning.

---------- Moorhead, George R., and Lentz, Austin N.
1957. CONTROLLED BURNING IN SOUTH JERSEY WOODLANDS
Rutgers Univ. Coll. Agr. Ext. Serv. Leaflet 201. 4 pp., illus.
Practical information for the landowner who wants to use controlled burning to improve and protect his woods.

Longwood, F. R.
1957. FORESTRY IN PUERTO RICO.
Univ. Maine, Maine Forester 1957: 17-24, illus.
The author, formerly in charge of forest utilization research at the U.S. Forest Service's Tropical Center

in Puerto Rico, describes the forests and forestry activities in that island.

Lull, Howard W.
1957. WHAT THEY SAID ABOUT FORESTS AND FLOODS IN PENNSYLVANIA 50 TO 75 YEARS AGO. Pa. Forests 37 (4): 91-92, 107.
A survey of early literature on this subject. Early conservationists in Pennsylvania had a warm concern about the water resource; then, about 1900, interest in the subject suddenly cooled off.

1957. FOREST WATERSHED MANAGEMENT RESEARCH IN PENNSYLVANIA. Pa. Forests 37: 41-42, illus.
Forest watershed-management research was begun in Pennsylvania in 1948 at the Delaware-Lehigh Experimental Forest, and research results are outlined. Additional work was begun recently on the Allegheny National Forest.

*
--- and Marquis, Ralph W.
1957. FORESTS GUARD THE POTOMAC.
Interstate Comn. on Potomac River Basin. 19 pp., illus. Washington.
Describes, in general terms, the problem posed by the Potomac River Basin, and the role forests play in protecting watershed lands. Remedial measures suggested.

--- and Marquis, Ralph W.
1957. FORESTS GUARD THE POTOMAC. In UPSTREAM CONSERVATION. Interstate Comn. on Potomac River Basin. 44-58, illus. Washington, D. C.
(See above.)

*
--- and Reigner, Irvin C.
1957. A PROGRAM OF WATERSHED-MANAGEMENT RESEARCH ON FOREST LANDS IN THE UPPER DELAWARE AND SUSQUEHANNA RIVER BASINS. Northeast. Forest Expt. Sta., Sta. Paper 92. 33 pp., illus.
Describes this region and its water, forest, and soil resources, and proposes a 5-point research program designed to find the data needed for the management of watersheds in the region.

--- and Storey, Herbert C.
1957. FACTORS INFLUENCING STREAMFLOW FROM TWO WATERSHEDS IN NORTHEASTERN PENNSYLVANIA. Jour. Forestry 55: 198-200, illus.
Comparison of the Lehigh and Lackawaxen watersheds (located about 12 miles apart) offers a striking example of the difference that forest cover, land use, and soil make in the streamflow of two watersheds that have similar climate.

Lynn, W. H., and Stoltenberg, C. H.
1957. MARKETING PULPWOOD.
Pa. Forests 37: 37-40, illus.
Advice to the forest land owner on finding buyers for pulpwood; planning ahead on marking, cutting, and peeling; cutting to the buyer's specifications; and selling in the form that will best meet his income needs.

*McConkey, Thomas W.
1957. HELICOPTER APPLICATION OF 2,4,5-T TO RELEASE SOFTWOOD GROWTH. Northeast. Forest Expt. Sta. 8 pp.

Report (presented to Society of American Foresters meeting) on use of aerial spray to release pine by killing hardwood competition. The experiment was generally successful, but killing of red maple sprouts poses problems.

*McLintock, T. F., and Bickford, C. A.
1957. A PROPOSED SITE INDEX FOR RED SPRUCE IN THE NORTHEAST. Northeast. Forest Expt. Sta., Sta. Paper 93. 30 pp., illus.

Average height of dominants at a given d.b.h. has been suggested as a possible expression of site index for a tolerant species like red spruce, and H. Arthur Meyer has recommended an exponential formula. The authors present such a measure of site quality for trial and testing.

*McQuilkin, W. E.
1957. THE KEY TO EFFECTIVE BASAL SPRAYING OF WOODY PLANTS: WET THE ROOT COLLAR. Jour. Forestry 55: 143-144.

Experimental treatment of scrub oak with 2,4,5-T on the Delaware-Lehigh Experimental Forest confirms findings of an earlier study reported by W. C. Bramble.

*---
1957. LOOK TO THE HARDWOODS! Northeast. Forest Expt. Sta., Sta. Paper 91. 17 pp.

Though three-fourths of the northeastern forest land is by nature hardwood country, most forestry in the past has favored softwoods. Now a changing attitude is sensed, and opportunities are seen in the hardwood resource. Outlines a research program for hardwood forest management.

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1957. FRILL TREATMENT WITH 2,4,5-T AND 2,4-D EFFECTIVE FOR KILLING NORTHERN HARDWOODS. Northeast. Forest Expt. Sta., Sta. Paper 97. 18 pp.

Methods used in the South by Chaiken were tested in Pennsylvania. Oil was found to be definitely better than water as a carrier. Discusses chemical concentrations and combinations, effect of season and tree size, and difference in vulnerability of species.

Marquis, Ralph W.
1957. A REPORT ON THE JOINT MEETING OF THE NORTHEASTERN WOOD UTILIZATION COUNCIL AND THE FORESTRY AND WOOD INDUSTRIES COMMITTEE OF THE NEW ENGLAND COUNCIL. Northeast. Logger 5 (7): 34-35, 43.

Summarizes eight papers presented on wood utilization and concludes that New England is moving forward rapidly in this field. The movement is bringing new industry, new employment, new hope for forest industries, and new interest in the economic management of forest lands.

Northeastern Forest Experiment Station
1957. ANNUAL REPORT 1956.
Northeast. Forest Expt. Sta. 70 pp.

Report on research activities and progress in research on forest management, watershed management, forest in-

sects and diseases, forest economics, and forest utilization. Annotated list of publications by staff and collaborators.

Northeastern Forest Experiment Station.

1957. NORTHEASTERN FOREST PEST REPORTER 1 (1957). Northeast. Forest Expt. Sta. 7 pp.

Notes on reported and estimated status of forest insects and diseases, and forecast of control problems.

1957. NORTHEASTERN FOREST PEST REPORTER 2 (1957). Northeast. Forest Expt. Sta. 7 pp.

Notes on reported status of forest insect and disease pests. Weather conditions make evaluation and prediction of pest activities unusually difficult.

1957. NORTHEASTERN FOREST PEST REPORTER 3 (1957). Northeast. Forest Expt. Sta. 8 pp.

Reports on status of forest insect and disease pests and control and survey efforts. Special reference to drought conditions and their effect on insect and disease activities.

Ostrander, Myron D.

1956. PROGRESS REPORT ON SURVEY OF BENDING STRENGTH VALUES OF DIMENSION LUMBER USED IN FARM WORK BUILDINGS IN THE NORTHEASTERN STATES. Forest Prod. Jour. 6: 232-235.

Study was made to determine range of strength values of local ungraded lumber for farm buildings, and to investigate practicality of developing simple rules for stress grading of such material.

*

1957. WEEVIL ATTACKS APPARENTLY UNRELATED TO HEIGHT OF EASTERN WHITE PINE. Northeast. Forest Expt. Sta. Forest Res. Note 67. 2 pp., illus.

Data collected during a study of white pine log defects in New York raise serious doubt about the common idea that weevil attacks are less frequent as trees grow taller. Based on 456 weevil injuries found when logs were sawed.

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--- and Foster, Clifford H.

1957. WEEVIL-RED ROT ASSOCIATIONS IN EASTERN WHITE PINE. Northeast. Forest Expt. Sta. Forest Res. Note 68. 2 pp.

Evidence collected in a white pine log-grade study in New York strongly suggests that white-pine weevil was responsible for much of the red rot (Fomes pini) found.

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--- and Stoltenberg, Carl H.

1957. VALUE LOSS FROM WEEVIL-CAUSED DEFECTS IN EASTERN WHITE PINE. Northeast. Forest Expt. Sta. Forest Res. Note 73. 2 pp.

Lumber degrade due to weevil defects was related to log grade, and a basis was established for estimating an appropriate reduction in log or tree value before sawing.

*Rushmore, Francis M.
1957. THE ADIRONDACK RESEARCH CENTER. Northeast. Forest Expt. Sta., Sta. Paper 98. 18 pp., illus.
A brief account of the Adirondack Region of New York, its forests and forestry problems, and the research work being done by the Northeastern Forest Experiment Station at its research Center at Paul Smiths, N.Y.

St. George, R. A., Johnston, H. R., and McIntyre, Thomas.
1957. THE OLD HOUSE BORER.
Pest Control 25 (2): 29-31, illus.
The old house borer (Hylotrupes bajulus L.) probably ranks second only to termites as a pest in buildings in the East. Description of the insect, symptoms of attack, damage done, and control methods.

*Sartz, Richard S.
1957. INFLUENCE OF LAND USE ON TIME OF SOIL FREEZING AND THAWING IN THE NORTHEAST. Jour. Forestry 55: 716-718, illus.
Found that open-land soils freeze before softwood forest soils, and softwood forest soils freeze before hardwood forest soils. Open-land soils thaw before softwood forest soils, but after hardwood forest soils.

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1957. SNOW AND FROST MEASUREMENTS IN A WATERSHED-MANAGEMENT RESEARCH PROGRAM. Northeast. Forest Expt. Sta. Sta. Paper 96. 9 pp., illus.
Describes periodic measurements of frost and snow on a small gaged watershed in the Hubbard Brook Experimental Forest in New Hampshire. Techniques and results.

Schreiner, Ernst J.
1957. WE NEED BETTER WHITE PINES FOR THE NORTHEAST.
Univ. Pa. Morris Arboretum Bul. 8: 39-40, 48, illus.
Damage caused by the white-pine weevil to eastern white pine has convinced tree-breeders that we need an insect- and disease-resistant white pine. Possibilities of obtaining one through hybridization are outlined.

1957. MARKING. (SAMPLE PLOT ON WOLF RUN EXPERIMENTAL FOREST.) Northeast. Forest Tree Improve. Conf. Proc. 4: 39-40.
Explains basis for a "genetical" marking on demonstration plot in Allegheny hardwood stand. Special attention was given to the release of selected seed trees.

---, Ehrhart, E. O., and Bennett, A. L.
1957. SUMMARY OF MARKING SYMPOSIUM. Northeast. Forest Tree Improve. Conf. Proc. 4: 41-47.
Compares the different demonstration markings made in a sample stand of Allegheny hardwoods by foresters, silviculturists, and geneticists. Concludes that genetical mass selection cannot now go beyond a good silvicultural marking.

*Simmons, Fred C.

1957. GUIDES TO MANUFACTURING AND MARKETING CHARCOAL IN THE NORTHEASTERN STATES. Northeast. Forest Expt. Sta., Sta. Paper 95. 20 pp., illus.

Practical advice for the small operator in building and operating cinder-block kilns, including equipment, methods, costs, and opportunities for marketing. Some data on the larger beehive kilns and briquetting.

1957. DEVELOPMENTS IN LOGGING--1956. Forest Prod. Jour. 7: 47-49, illus.

Fuller utilization of cut trees is resulting from increased chip use, integrated logging, and development of new equipment. Trends toward integrated operations are reviewed and new equipment developments are described. Extensive bibliography of logging literature.

1957. FULL TREE UTILIZATION IN WEST VIRGINIA. South. Lumberman 194 (2427): 60-64, illus.

A case study of operations by the Meadow River Lumber Co. of Rainelle, W. Va. They do their own logging (by railroad), bring trees full length to the mill for bucking. Lumber, flooring, shoe heels, and dimension stock are produced from sawlogs; cull sections, tops, and heavy residues are made into chips for metallurgical uses.

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1957. ENGINEERING EFFICIENCY IN LOGGING AND MILLING. South. Lumberman 195 (2441): 121-124, illus.

Because the products that compete with lumber are produced by industries that are engineered for efficiency, the logging and milling industry must increase its efficiency to survive.

1957. MECHANIZATION AND AUTOMATION IN SMALL SAWMILLS. Amer. Soc. Mech. Engin. Paper 57-A--48. 8 pp., illus.

Describes advantages of the small sawmill (10 to 20 M board foot production), which is becoming the backbone of the eastern lumber industry; and methods and step-by-step requirements for mechanization and automation.

1957. A SMALL SAWMILL ENTERPRISE. U. S. Internatl. Coop. Admin., Tech. Aids Branch, Office Indus. Resources. 96 pp., illus. Washington.

An operations manual for cooperative program use, covering requirements for starting a business, choice of machinery, mill location, layout, and operation, recruiting and training labor, marketing, and cost control.

1957. PRODUCTION AND USE OF SAWMILL RESIDUES IN THE NORTHEAST. Northeast. Logger 5 (9): 12-13, 46-51, illus.

Most Northeastern sawmills score very well in getting lumber out of their logs. Reviews current trends toward

integrated logging, use of log debarkers, growing markets for slabs and edgings, and use of fine residues for mulch.

Simmons, Fred C.
1957. THE IMPACT OF NEW METHODS AND MACHINERY ON FOREST MANAGEMENT. Northeast. Logger 6 (1): 34-35, 54-56, illus.

Tells forest managers that new utilization practices and new types of equipment (such as four-wheel logging tractors and debarkers) may affect the types of stands that management should aim for.

1957. THE QUESTION CORNER.
Northeast. Logger 5 (9): 26, illus.
Northeast. Logger 6 (3): 39, illus.

Snow, Albert G., Jr.
1957. NAVAL STORES PRODUCTION METHODS. In Forest Farmer Manual: a guidebook for Southern timberland owners. 5th edit.: 91-94. Forest Farmers Assoc., Atlanta.

Stoltenberg, Carl H.
1957. STUMPAGE PRICES AS A PRODUCTION GUIDE IN FORESTRY. Soc. Amer. Foresters Proc. 1956: 134-137, illus.

By itself, stumpage price is not a logical gage of pulpwood value in the South. Perhaps a careful analysis of all production costs of a pulp and paper industry, and the role of stumpage price in production planning, will encourage more productive forestry practices on non-company-owned forest land.

Toole, E.H., Snow, A.G., Toole, V.K., and Borthwick, H.A.
1956. EFFECTS OF LIGHT AND TEMPERATURE ON GERMINATION OF VIRGINIA PINE SEEDS. Plant Physiol. Proc. 31 (Supplement): 36.

In preliminary studies seeds of Pinus virginiana failed to germinate in the dark but germinated well after exposure to red light, within a narrow range of temperatures.

Trimble, George R., Jr.
1957. CHAFF SEEDING DOES NOT INHIBIT TREE REPRODUCTION. Northeast. Forest Expt. Sta., Forest Res. Note 77. 2 pp.

Chaff-seeding was tried in 1953 to stabllize logging roads in West Virginia. Examination 5 years later showed that the resulting plant cover did not hinder natural establishment of hardwood tree seedlings.

(Trimble, George R., Jr., et al.)
1957. NEW HAMPSHIRE GUIDES FOR LOGGING ROADS AND SKID TRAILS. Univ. N. H. Ext. Serv., Ext. Folder 35. 4 pp., illus.

Practical guides for locating, constructing, and maintaining logging roads and skid trails for efficient logging, with emphasis on measures to prevent erosion and damage to the water resource.

*Trimble, George R., Jr., and Sartz, Richard S.
1957. HOW FAR FROM A STREAM SHOULD A LOGGING ROAD BE LOCATED? Jour. Forestry 55: 339-341, illus.

A rule of thumb is offered for determining how wide a filter strip is needed along logging roads to keep sediment from getting into streams. Based on studies made in the White Mountains of New Hampshire.

*Waterman, Alma M.
1957. CANKER AND DIEBACK OF POPLARS CAUSED BY DOTHICHIZA POPULEA. Forest Sci. 3: 175-183, illus.

Inoculations of 92 clones representing 38 hybrid poplars, with black or balsam poplars and cottonwoods as parents, showed that 75 were moderately or highly susceptible. Inoculations and cultures failed to prove any relationship between D. populea and Cenangium populneum.

---------- and Hansbrough, J. R.
1957. MICROSCOPICAL RATING OF DECAY IN SITKA SPRUCE AND ITS RELATION TO TOUGHNESS. Forest Prod. Jour. 7: 77-84, illus.

Report of a study to determine whether reduction in toughness caused by wood-rotting fungi might be estimated in relation to microscopical changes in the wood. Such a method offers promise for use with other fungi and other woods.

*Waters, W. E., and Waterman, Alma M.
1957. FOREST INSECT & DISEASE CONDITIONS IN THE NORTHEAST --1956. Northeast. Forest Expt. Sta., Sta. Paper 94. 23 pp.

Brief review of the general forest insect and disease situation in the Northeast and status of attacks by the major pests. Tabulation of insect and disease pests, locality affected, and recommended control action.

*Weitzman, Sidney, and Reinhart, Kenneth G.
1957. WATER YIELDS FROM SMALL FORESTED WATERSHEDS. Jour. Soil and Water Conserv. 12: 56-59, illus.

Describes watershed research on the Fernow Experimental Forest in West Virginia and indicates how rainfall and runoff data can be used in selecting watersheds for different purposes such as a city water supply, a site for an industry, or a farm pond.

---------- and Trimble, G. R., Jr.
1957. SOME NATURAL FACTORS THAT GOVERN THE MANAGEMENT OF OAKS. Northeast. Forest Expt. Sta., Sta. Paper 88. 40 pp., illus.

Study of oak stands in the northern Appalachians indicates that site quality should be the controlling factor in managing such stands. Silvicultural guides based on site index are offered.

Wright, Jonathan W.
1957. NEW CHROMOSOME COUNTS IN ACER AND FRAXINUS. Univ. Pa. Morris Arboretum Bul. 8: 33-34.

Chromosome counts for 29 maple species and 20 ash species. Counts for several of these species are reported here for the first time.

Wright, Jonathan W.

1957. WHITE PINE IMPROVEMENT THROUGH GENETICS RESEARCH. Soc. Protect. N.H. Forests, Forest Notes 54: 14-17, illus.

Increased activity in forest genetics offers hopes that in two or three decades genetics may be able to develop a white pine that has resistance to both the blister rust and the white-pine weevil.

1957. CULTIVATED FIRS IN THE PHILADELPHIA AREA. Univ. Pa. Morris Arboretum Bul. 8: 11-18, illus.

Describes taxonomic characteristics, geographic origin, and growth performance in the Northeast of some American, Mediterranean, Japanese, Chinese, Siberian, and Korean firs. Discusses relative merits; suggests seed sources.

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1957. A BIBLIOGRAPHY ON FOREST GENETICS AND FOREST TREE IMPROVEMENT, 1955. Northeast. Forest Expt. Sta., Sta. Paper 90. 60 pp.

Lists 717 published reports in standard forestry, botanical, and abstracting journals, experiment station publications, both American and foreign. List is alphabetical; index by species or subject matter.

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1957. EFFECTS OF CONTINUOUS BAGGING OF WHITE PINE CONES. Northeast. Forest Expt. Sta., Sta. Paper 99. 6 pp.

Continuous enclosure of pollinated white pine branches in synthetic sausage casing was tested as a method of increasing cone and seed set. As a technique, this proved successful for white pine but not for other pine species.

--- and Baldwin, Henry I.

1957. THE 1938 INTERNATIONAL UNION SCOTCH PINE PROVENANCE TEST IN NEW HAMPSHIRE. Silvae Genetica 6: 2-14, illus.

One of a series of IUFRO tests of Scotch pine provenance was established on the Fox and Vincent State Forests near Hillsboro, N.H., in 1938. This is a report on the behavior of the material tested. Summaries in French, German.

*

Zeedyk, William D.

1957. WHY DO BEARS GIRDLE BALSAM FIR IN MAINE? Jour. Forestry 55: 731-732.

Forest survey crews in the northern counties of Maine reported finding balsam fir, red spruce, and northern white-cedar trees girdled by bears.

Agriculture-Forest Service-Upper Darby

REGION SERVED BY THE
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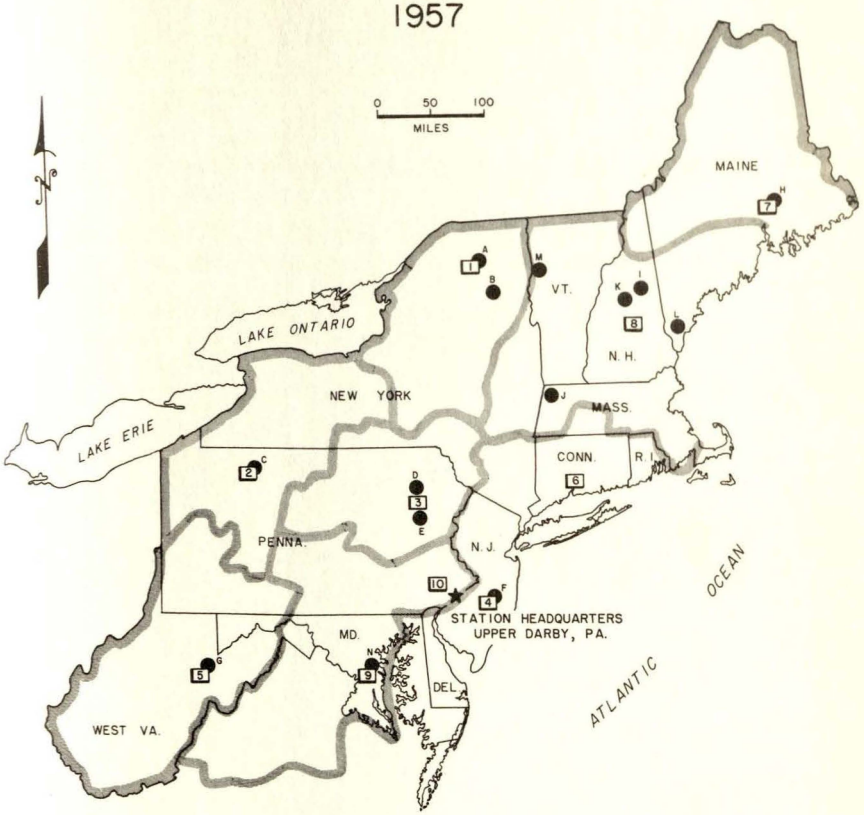
1957



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